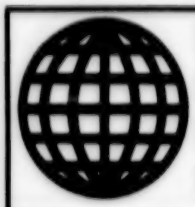
JPRS-UPM-89-005
12 SEPTEMBER 1989



FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Science & Technology

USSR: Physics & Mathematics

Science & Technology
USSR: Physics & Mathematics

JPRS-UPM-89-005

CONTENTS

12 SEPTEMBER 1989

Acoustics

Spatiotemporal Self-Concentration of High-Power Ultrasound in High-Viscosity Fluid
[V. A. Aseman, F. V. Bunkin, et al.; AKUSTICHESKIY ZHURNAL, Vol 35 No 3, May-Jun 89] 1
Acoustical Tomography of Pulsed Laser Beams
[V. P. Zharov, Ya. O. Simanovskiy; AKUSTICHESKIY ZHURNAL, Vol 35 No 3, May-Jun 88] 1
Formation of Active Regions Behind Shock Wave in Weakly Ionized Nonequilibrium Plasma
[V. A. Gorshkov, A. I. Klimov, et al.; ZHURNAL TEKHNICHESKOY FIZIKI, Vol 59 No 4, Apr 89] 1
Nonequilibrium Processes Along Profile of Shock Wave
[A. M. Bashlykov, V. Yu. Velikodnyy; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 12 Mar 89] 1
Formation of Thermal Structures During Propagation of Strongly Nonlinear Sound Through Gases
[A. I. Malkin; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Feb 89] 2
Measurement of Metal Temperatures During Impact Compression With Thermocouple
[S. N. Ishutkin; FIZIKA GORENIYA I VZRYVA, Vol 25 No 1, Jan-Feb 89] 2
Velocities of Wave Perturbations Behind Shock Wavefront in Aluminum
[A. Yu. Dolgoborodov, I. M. Voskoboynikov; FIZIKA GORENIYA I VZRYVA, Vol 25 No 1, Jan-Feb 89] . 2
Effect of Shock Wave Action on Chemical Activity
[S. S. Batsanov, V. P. Bokarev, et al.; FIZIKA GORENIYA I VZRYVA, Vol 25 No 1, Jan-Feb 89] 3
Hysteresis of Phase Transformations Under Impact Compression
[O. N. Breusov; FIZIKA GORENIYA I VZRYVA, Vol 25 No 1, Jan-Feb 89] 3
Expansion of Materials After Intense Heating in Strong Shock Waves
[M. M. Rusakov, V. N. Nogin; FIZIKA GORENIYA I VZRYVA, Vol 25 No 1, Jan-Feb 89] 3
Acoustoelectromagnetic Solitons in Crystals With Nonlinear Electrostriction
[G. N. Burlak; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Jan 89] 3
Theoretical Strength of a Crystal in Shock-Wave Loading Conditions
[M. A. Mogilevskiy, I. O. Mynkin; FIZIKA GORENIYA I VZRYVA, Vol 24 No 6, Nov-Dec 88] 4
Structural Changes in Amorphous Metallic Alloys Under Shock Wave Loading
[V. I. Kirko, A. A. Kuzovnikov; FIZIKA GORENIYA I VZRYVA, Vol 24 No 6, Nov-Dec 88] 4
Molecular-Dynamic Analysis of the Atomic Structure of a Material Under Shock Wave Propagation Loading
[S. Yu. Korostelev, S. G. Psakhye, et al.; FIZIKA GORENIYA I VZRYVA, Vol 24 No 6, Nov-Dec 88] 4
Radiation From Shock-Compressed Halogen Derivatives of Methane
[M. F. Gogulya, I. M. Voskoboynikov; FIZIKA GORENIYA I VZRYVA, Vol 24 No 6, Nov-Dec 88] 5
Efficient Excitation of Rayleigh Waves by Weak Shock Wave Triggered by Spark Discharge in Air
[S. V. Korolev, V. V. Krylov; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 12 Nov 88] 5
Structure of Shock Wavefront in Metals
[O. R. Osipova, G. I. Kanel, et al.; TEPLOFIZIKA VYSOKIKH TEMPERATUR, Vol 26 No 6, Nov-Dec 88] 5
Use of Acoustooptic Filters in Automatic Emission Spectrum Analyzers
[I. V. Galishnikov, L. K. Mikhaylov, et al.; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 50 No 2, Feb 88] 5

Lasers

Kinetic Model of Active Medium of XeCl-Laser With Electron-Beam Pumping
[A. M. Boychenko, V. I. Derzhnev, et al.; KVANTOVAYA ELEKTRONIKA, Vol 16 No 2, Feb 89] 7
Efficient Compression of High-Energy Laser Pulses in Fiber-Optic Compressor Gratings
[Ye. M. Dianov, L. M. Ivanov, et al.; KVANTOVAYA ELEKTRONIKA, Vol 16 No 2, Feb 89] 7
Mode Locking By Colliding Pulses in $YA10_3$:Nd^{3+}-Laser
[Sh. Burdulis, G. Sinkyavichyus, et al.; KVANTOVAYA ELEKTRONIKA, Vol 16 No 2, Feb 89] 7
Kinetics of Processes in CO_2 Waveguide Laser With Control of Emission Pulseform
[A. S. Biryukov, N. I. Lipatov, et al.; KVANTOVAYA ELEKTRONIKA, Vol 16 No 2, Feb 89] 8

Mutual Focusing of Electron Beam and Electromagnetic Wave in Free-Electron Lasers
[V. G. Baryshevskiy, I. Ya. Dubovskaya, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Jan 89] 8
Quasi-Continuous-Wave $Al_2O_3:Ti^{3+}$ Power Laser Pumped by Cu-Vapor Laser and Tunable Over 680-960 nm Range of Spectrum
[S. G. Bartoshevich, V. D. Burlakov, et al.; OPTIKA ATMOSFERY, Vol 1 No 12, Dec 88] 8
Stability and Characteristics of Striae Locking in Cataphoretic Lasers and Prospects of Their Operation in This Mode
[V. A. Vaskov, S. A. Gonchukov, et al.; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 9
New Evidence About Dynamics and Spectrum of Picosecond Three- Component Injection Laser
[P. P. Vasilyev, I. S. Goldobin; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 9
Amplitude-Frequency Characteristics of Rotating Solid-State Ring Laser With Nonsteady Acoustooptical Mode Locking
[N. V. Kvartsov, S. V. Parfenov; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 9
Generation of Nanosecond and Microsecond Pulses in Nd-Laser With Negative Feedback
[N. S. Vorobyev; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 10
Pumping Gase Laser With High-Intensity Ion Beam in Accelerator With Inductive Energy Storage and Plasma-Type Current Chopper
[M. S. Arteyev, B. M. Kovalchuk, et al.; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 10
Use of Open Cavity for Parametric Free-Electron Laser
[V. I. Alekseyev, Ye. G. Bessonov, et al.; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 10
Evaporation of Target and Formation of Absorption Waves in Air Under Ultraviolet Laser Radiation
[Ye. O. Danilov, V. A. Danilychev, et al.; KVANTOVAYA ELEKTRONIKA, Vol 15 No 12, Dec 88] 10
Phase Self-Conjugation of CO_2-Laser Radiation During Four-Wave Interaction
[A. A. Betin, K. V. Yergakov, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Nov 88] 11
Numerical Simulation of Natural Convection of Compressible Gas Heated by Laser
[S. V. Kapitskiy, V. I. Mashendzhinov, et al.; TEPLOFIZIKA VYSOKIKH TEMPERATUR, Vol 26 No 6, Nov-Dec 88] 11

Magnetohydrodynamics

Secondary Flow in Channels of Large-Scale MHD-Generators: Nonlinear Effects Under Nominal Operating Conditions
[G. Yu. Alekseyev, V. A. Bityurin; TEPLOFIZIKA VYSOKIKH TEMPERATUR, Vol 26 No 6, Nov-Dec 88] 12

Nuclear Physics

The Superstring Z'-Boson At UNK Energies
[V. A. Bednykov, S. G. Kovalenko; YADERNAYE FIZIKA, Vol 49 No 3, Mar 89] 13
Degenerate Surfaces and Solitons. The Handle Gluing Operator
[A. A. Gerasimov; YADERNAYE FIZIKA, Vol 49 No 3, Mar 89] 13
Production of Cumulative Protons During Interaction of Neutrinos and Photoemulsion Nuclei
[Yu. A. Batusov, O. M. Kuznetsov, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, 25 Feb 89] 13
Mechanical Instability of Conductor During Electrical Breakdown
[E. K. Anderzhanov, I. I. Divnov, et al.; DOKLADY AKADEMII NAUK SSSR, Vol 304 No 4, Feb 89] 14
Muon Catalysis in Dense Nonhomogeneous Plasma
[L. I. Menshikov, V. A. Shakirov; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 95 No 2, Feb 89] 14
Stability of Three-Dimensional Structures and Annihilation of Soliton-Antisoliton Pairs in Discrete Phi^4-Model
[V. V. Beloshapkin, G. P. Berman, et al.; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 95 No 2, Feb 89] 14
Classically Bound State of Two Solitons in Skyrme Model
[B. Ye. Shtern; YADERNAYA FIZIKA, Vol 49 No 2, Feb 89] 15
Quantum Soliton in Stochastic Field
[I. V. Krive, A. S. Rozhavskiy, et al.; YADERNAYA FIZIKA, Vol 49 No 2, Feb 89] 15
Possibility of Detecting Weak Neutral Currents in Cluster-Forming Light Nuclei
[M. M. Nesterov, I. S. Okunev; PISMA V ZHURNAL EKSPERIMENTALONY I TEORETICHESKOY FIZIKI, 10 Dec 88] 15

Polarized Solitons in Three-Level Media
[A. M. Basharov, A. I. Maymistov; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 94 No 12, Dec 88] 15
Disruptive Fluctuations and Solitons
[A. I. Melker; FIZIKA TVERDOGO TELA, Vol 30 No 11, Nov 88] 16
Spin Dependence of Fissionability in Experiments Dealing With Fission of Oriented ^{235}U Nuclei Upon Bombardment by Fast Neutrons
[N. N. Gonin, M. A. Guseynov, et al.; YADERNAYA FIZIKA, Vol 48 No 6 (12), Dec 88] 16
Excitation Energies for Double Isobar-Analog States in Heavy Nuclei
[I. V. Poplavskiy; YADERNAYA FIZIKA, Vol 48 No 6 (12), Dec 88] 16
Discovery of Exotic Meson With 1.9 GeV Mass Decaying in Eta'Eta Channel
[S. V. Donskov, A. V. Inyakin, et al.; YADERNAYA FIZIKA, Vol 48 No 6 (12), Dec 88] 17
Two-Component Solitons in Molecule Chains With Hydrogen Bonds
[V. N. Kshcheyev; IZVESTIYA AKADEMII NAUK LATVIISKOY SSR: SERIYA FIZICHESKIKH I TEKHNICHESKIK NAUK, No 6, Nov-Dec 88] 17

Optics, Spectroscopy

Experimental Study Concerning Formation of Reflecting Surface of Adaptive Mirror
[V. V. Apollonov, Ye. A. Ivanova, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Jan 89] . 18
Nonlinear Pairing of Light and Dark Optical Solitons
[V. V. Afanasyev, Ye. M. Dianov, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, 10 Dec 88] 18
Characteristics of Mechanism of Fine-Structure Formation in X-Ray Absorption Spectra of Nonmetals
[A. A. Povlychev, A. S. Vinogradov, et al.; FIZIKA TVERDOGO TELA, No 12, Dec 88] 18
Feasibility of Producing Single-Mode Film Optics
[Ye. D. Kim; DOKLADY AKADEMII NAUK SSSR, No 4, Nov 88] 18
New Ferromagnetics Pyrochloric Structure
[I. O. Troyanchuk, V. N. Derkachenko; FIZIKA TVERDOGO TELA, Vol 30 No 11, Nov 88] 19
Luminescence of Solutions of Complex Organic Compounds Excited by High-Intensity Electron Beam
[V. V. Gruzinskiy, A. V. Kukhto; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 50 No 2, Feb 88] .. 19
Doppler-Free Spectroscopy of Optically Dense Gaseous Media by Selective Reflection
[V. A. Sautenkov, A. M. Akulshin, et al.; ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 50 No 2, Feb 88] 19

Plasma Physics

Charge Distribution and Correlation Functions Near Boundary of Slightly Nonideal Plasma
[M. M. Shapiro, Yu. V. Tabachnik, et al.; IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA, Vol 32 No 3, Mar 89] 20
Impact Compression of Porous Iron, Copper, Tungsten, and Their Equation of State Under Terapascal Pressures
[R. F. Trunin, A. B. Medvedev, et al.; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 95 No 2, Feb 89] 20
Oscillations of Radiation Intensity in Impact-Heated Xenon Plasma
[G. K. Tumakayev, Z. A. Stepanova; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Jan 89] 20
Nonequilibrium Supercooled Beam Plasma
[V. L. Bychkov, A. V. Yeletskiy, et al.; FIZIKA PLAZMY, Vol 14 No 12, Dec 88] 21
Comments on the Dirichlet Problem for an Ultrahyperbolic Equation and Integral Geometry on a Sphere
[V. P. Burskiy; USPEKHI MATEMATICHESKIKH NAUK, Vol 43 No 5 (263), Sep-Oct 88] 21

Superconductivity

Crystal Chemistry and High-Temperature Superconductivity
[V. I. Lebedev; VESTNIK LENINGRADSKOGO UNIVERSITETA, SERIYA 7: GEOLOGIYA I GEOGRAFIYA, No 1 (7), Mar 89] 22
Possibility of High-Temperature Superconductivity by Interband Electron-Phonon Mechanism
[P. Konsin, N. Kristofel, et al.; IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA I MATEMATIKA, Vol 38 No 1, Jan-Mar 89] 22

Structure of Superconducting Phases of UBe_{13} and $U_{1-x}Th_xBe_{13}$
[I. A. Lukyanchuk, V. P. Mineyev; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 95 No 2, Feb 89] 22
Bound States of Fermions and Superconducting Ground State in 2 + 1 Gauge Theory With Topological Mass Term
[Ya. I. Kogan; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, 25 Feb 89] 22
Atomic Structure in $YBa_2Cu_3O_{7-d}$ Single Crystals With Intermediate-Range Oxygen Content
[V. N. Molchanov, L. A. Muradyan, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, 25 Feb 89] 23
Localization Effects in Atomically Disordered High-Temperature Superconductors
[B. A. Aleksashin, V. I. Voronin, et al.; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 95 No 2, Feb 89] 23
Superconductivity in Tl-Ca-Ba-Cu-O System
[I. V. Vodolazskaya, V. I. Voronkova, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Jan 89] 23
Cathodoluminescence of Y-Ba-Cu-O High-Temperature Superconductors
[M. N. Popova, Ye. P. Khlybov, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, No 11, 10 Dec 88] 24
Characteristic Loss Spectroscopy of YBa2Cu307-d Superconductor Ceramic
[I. V. Kireyev, M. N. Mikheyeva, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, 10 Dec 88] 24
Raman Scattering of Light in Tunneling-Transparent Superlattices
[A. O. Govorov, A. V. Chaplik; ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI, Vol 94 No 12, Dec 88] 24
Critical State of and Hystersis Losses in Metal-Oxide Superconductors
[Yu. F. Revenko, A. I. Dyachenko, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Nov 88] 25
Structural and Physical Characteristics of Bi-Sr-Ca-Cu-O Superconductor Crystals
[M. P. Petrov, A. I. Grachev, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Nov 88] 25
New Method of Producing Photosensitive Schottky Barriers With Schistose InSe and GaSe Semiconductors
[M. V. Tovarnitskiy, V. K. Lukyanyuk, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 26 Nov 88] 25
Pressure Dependence of Fluctuation Effects in Cermet Superconductors
[V. M. Svistunov, V. Yu. Tarenkov, et al.; FIZIKA TVERDOGO TELA, Vol 30 No 11, Nov 88] 26
Frequency Mixing in Josephson Junction Made of $YBa_2Cu_3O_x$ Ceramic
[A. V. Drobinin, V. S. Lutovinov; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 12 Nov 88] 26
Effect of Constant Magnetic Field on High-Frequency Surface Resistance of $YBa_2Cu_3O_{7-d}$ Ceramic
[O. G. Vendik, M. M. Gaydukov, et al.; PISMA V ZHURNAL TEKHNICHESKOY FIZIKI, 12 Nov 88] . 26
Determination of the Depth of Penetration of a Magnetic Field Into a $YBa_2Cu_3O_7$ Superconducting Thin Single Crystal Film by Polarized Neutron Reflection
[S. V. Gaponov, Ye. B. Dokukin, et al.; PISMA V ZHURNAL EKSPERIMENTALNOY FIZIKI, 10 Mar 88] 27

UDC 534.222

Spatiotemporal Self-Concentration of High-Power Ultrasound in High-Viscosity Fluid

18620194a Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 3, May-Jun 89 (manuscript received 21 Jun 88) pp 543-546

[Article by V. A. Aseman, F. V. Bunkin, G. A. Lyakhov, A. K. Proskuryakov, and K. F. Shchipilov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] An experimental study of ultrasound self-focusing and self-brightening in high-viscosity fluids at low temperatures was made, the 20-(-8) deg C range including the temperature at which absorption of sound is maximum and the temperature coefficient of the speed of sound is large. Into glycerin and into triacetin was injected a 1.5 cm wide 2 MHz sound beam with a power of up to 40 W, the sound signal having a very short rise time. Cooling with nitrogen was controlled so as to let the temperature stabilize at any level within 0.1 deg C uniformly over the entire volume. The distribution of sound pressure was measured with a quasi-point hydrophone. The results indicate that the sound pressure drops depthwise, but less steeply as the intensity of incoming sound is increased. They confirm that self-focusing alone does not compress a sound beam and produce a pressure pulse, that interaction of self-focusing and self-brightening at a sufficiently high intensity of incoming sound is necessary for this. The pressure pulse decays in time, in damped oscillations when the intensity of incoming sound exceeds a threshold level. In more viscous triacetin, moreover, a self-darkening effect was recorded at temperatures approaching -70 deg C, within the range of a positive temperature coefficient of sound absorption. The threshold of thermal self-concentration was found to be at a lower temperature in triacetin than in glycerin. Figures 3; references 5: 4 Russian, 1 Western.

UDC 535.211:534.142-13

Acoustical Tomography of Pulsed Laser Beams

18620194b Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 35 No 3, May-Jun 88 (manuscript received 22 Jun 88) pp 556-557

[Article by V. P. Zharov and Ya. O. Simanovskiy, Moscow Higher Technical School imeni N. E. Bauman]

[Abstract] Acoustical tomography of pulsed laser beams in a transverse stream of a weakly light-absorbing gas is analyzed theoretically, the radial distribution of energy density in a laser beam being reconstructable on the basis of pressure measurements along sound waves generated in a medium which heats up upon absorption of some radiation. The aperture of the laser beam is assumed to be so large that it takes a much longer time for a sound wave to travel across than for the acoustic transducer to respond to a pressure pulse. The interpretation of such measurements is based on the known solution to the problem of sound wave excitation within a region of the medium where heating by a light pulse has determined the initial pressure distribution. References 3: Russian.

UDC 02;04;07

Formation of Active Regions Behind Shock Wave in Weakly Ionized Nonequilibrium Plasma

18620200a Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 59 No 4, Apr 89 (manuscript received 2 Oct 88) pp 135-137

[Article by V. A. Gorshkov, A. I. Klimov, A. B. Fedotov, and F. V. Shugayev, Moscow State University imeni M. V. Lomonosov, Department of Physics]

[Abstract] An experimental study of shock waves in weakly ionized gaseous nonequilibrium plasmas was made, for confirmation and closer scrutiny of rises of the electron concentration behind a shock wave to levels above its level at the wavefront. Both constant-current glow discharge and pulse-current flash discharges were produced in a tube containing Ar, CO_2, or Ar with an admixture of CO_2, the pressure being varied over the 1-30 torr range. The temperature in the glow discharges was measured with a Chromel-Alumel thermocouple. For diagnostic testing of the plasmas were used two identical microwave interferometers operating at the 8 mm wavelength linearly over the $3x10^{10}$-$5x10^{12}$ cm^{-3} range of electron concentration, two photoresistor-type infrared receivers with narrow-band filters, a total radiation receiver, and a laser schlieren apparatus. The experiment has yielded information about transient process under the various conditions, revealing not only one but up to four successive rises of electron concentration behind a shock wave and thus correspondingly as many companion plasma formations interspersed by "valleys" with attendant dips of the integral plasma luminosity. Figures 2; tables 1; references 4: 2 Russian, 2 Western (1 in Russian translation).

Nonequilibrium Processes Along Profile of Shock Wave

18620198a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 5, 12 Mar 89 (manuscript received 21 Dec 88) pp 24-28

[Article by A. M. Bashlykov and V. Yu. Velikodnyy]

[Abstract] The thermal flux distribution along the profile of a shock wave is analyzed on the basis of the system of Boltzmann equations describing the kinetics in gaseous mixtures, specifically binary ones, this system of equations being solved by a modification of the Tamm-Mott-Smith method which requires no other assumptions than those required in moment methods. The solution, for appropriate boundary conditions, relates the sought thermal flux distribution to the distribution of partial temperatures. Calculations for a shock wave with Mach 4.4 velocity in a He-Xe mixture (94 pct He, 6 pct

Xe) and for a shock wave with Mach 1.58 velocity in a He-Ar mixture (89.7 pct He, 10.3 pct Ar) have yielded distribution of thermal flux and also that of the mean temperature, the results agreeing with the "heavy sphere" model of a region where the thermal flux in the heavy "impurity" (small volume fraction) component flows along rather than against the gradient of its partial temperature. Figures 2; references 7: 2 Russian, 5 Western.

Formation of Thermal Structures During Propagation of Strongly Nonlinear Sound Through Gases

18620204 Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 4, 26 Feb 89 (manuscript received 13 Dec 88) pp 60-64

[Article by A. I. Malkin, Moscow Institute of Construction Engineering imeni V. V. Kuybyshev]

[Abstract] Heating of a gas to high temperatures by a strongly nonlinear sound wave is analyzed for formation of thermal structures, considering that energy within a sound wave is dissipated on shock fronts when the acoustic Reynolds number is much larger than unity and that the normalized increment of entropy at a shock front is of third-order smallness relative to the normalized pressure amplitude. The structurization time is accordingly inversely proportional to the pressure drop cubed. An equation describing slow evolution of thermal nonhomogeneity is derived from the applicable equations of gas dynamics, after they have been averaged in Lagrangian coordinates, in the approximation of constant-pressure heating of a "fast responding" acoustic medium whose Reynolds number approaches infinity and ignoring the reflected wave. While the thermal conductivity of the gas is not a significant factor influencing the evolution of thermal nonhomogeneity during the short transient period, its finiteness becomes a significant factor in shaping the region of large temperature gradients near the source after the temperature has peaked. Two mechanisms of instability are identified for the purpose of stability analysis and one of them, namely increasing energy dissipation within the high-temperature region, is shown to be of little consequence. Dangerous to stability is shown to be interaction of sound and heat wavefront, which may lead to Rayleigh-Taylor instability in a variable acceleration field. Thermal structurization was observed in standard air, where a 50 kHz sound generator with a power density of 0.25 W/cm^2 produced thermal nonhomogeneity at a distance 30 cm away within a characteristic time of 120 s (ratio of pressure drop to energy density 0.01, acoustic Reynolds number 600) and instability developed at temperatures above 750 K within approximately 4 min. Figures 1; references 6: Russian.

UDC 539.89+536.53

Measurement of Metal Temperatures During Impact Compression With Thermocouple

18620139a Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 15 Jan 88) pp 77-81

[Article by S. N. Ishutkin, Novosibirsk]

[Abstract] Measuring the temperature of a metal during its impact compression on the basis of the Seebeck effect is so far the simplest way, provided that the pressure dependence of the Seebeck coefficient in the gigapascal range is known and its temperature dependence is taken into account when the temperature drop along the thermocouple exceeds its nominal range. These relations under variable high pressure have been determined experimentally in a situation involving compression of a copper target by impact of a plane shock wave which an explosive charge has generated upon detonation and measurement of the copper temperature with a Cu-constantan thermocouple, the latter shielded from the cartridge and its wires insulated with teflon except at the bare junction. Expressions for the voltage signal from such a thermocouple during the compression process including its preshock and postshock stages are derived in accordance with applicable thermoelectric and thermodynamic relations, taking into account deviation of the temperature-dependent Seebeck coefficient under high pressure from its magnitude under normal static pressure. Considering that the relative deviation in this case has been found not to exceed 20 percent, a procedure is established for measuring the temperature of copper during impact compression accurately within 10 percent with a Cu-constantan thermocouple behind the shock wavefront. The author thanks V. M. Titov, V. V. Pay, and G. Ye. Kuzmin for helpful discussions, V. N. Zelenov and M. A. Fedotenko for assisting in the experiments. Figures 2; tables 1; references 16: 6 Russian, 10 Western.

UDC 539.63

Velocities of Wave Perturbations Behind Shock Wavefront in Aluminum

18620139b Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 20 Apr 87) pp 88-93

[Article by A. Yu. Dolgoborodov and I. M. Voskoboynikov, Moscow]

[Abstract] An experimental study was made concerning impact compression of solid and porous aluminum, the velocity field of rarefaction and secondary shock waves behind the primary shock wavefront being recorded and measured in CCl_4 serving as acoustic fluid behind the aluminum targets. In the first series of tests 0.9 mm and 1.9 mm thick aluminum disks 40 mm in diameter, after

having been accelerated by explosion products to velocities of 2700 m/s and 4580 m/s over a distance of 6 mm, struck aluminum targets 50 mm in diameter. In the second series of tests thin solid aluminum shields on the surface of CCl_4 were shocked by products of TNT explosion. The data have been analyzed and evaluated on the basis of applicable theoretical and semiempirical relations. Figures 4; tables 2; references 20: 14 Russian, 6 Western.

UDC 539.89

Effect of Shock Wave Action on Chemical Activity

18620139c Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 28 Apr 87, after completion 14 Dec 87) pp 94-95

[Article by S. S. Batsanov, V. P. Bokarev, and Ye. V. Lazareva, Mendeleyevo]

[Abstract] An experimental study of five reacting substances was made for the purpose of determining the effect of shock wave action on their chemical activity. Powder specimens of Ti and TiO_2*, TiO, Ti* and Al_2O_3, Mg and Al_2O_3, and $CdCO_3$ were placed in cylindrical tubes made of the metal they contained so as to avoid influencing the reaction temperature by an extraneous metal such as iron, Al_2O_3 being added to the contents as a harder component ensuring multiple reflections. These tubes 10 mm in diameter were fitted into 3 mm thick protective steel cylinders with an inside diameter of 10 mm and shock loaded with products of RDX explosion. The initial contents of the tubes and their contents after this treatment (Ti having been oxidized to TiO, TiO_2 having been reduced to TiO, $CdCO_3$ having been reduced to CdO, MgO and Al_2O_3 having formed $MgAl_2O_4$) were examined by the methods of differential thermal analysis, infrared spectroscopy, and X-ray diffraction in a DRON-UM-1 diffractometer with CuK_α-radiation source. Shock treatment was found to increase the defectiveness of TiO and cause its transition from the ordered monoclinic phase to the cubic phase with random distribution of vacancies. Tables 1; references 9: 5 Russian, 4 Western (1 in Russian translation).

UDC 539.63

Hysteresis of Phase Transformations Under Impact Compression

18620139d Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 5 May 87, after completion 6 Oct 87) pp 108-113

[Article by O. N. Breusov, Chernogolovka]

[Abstract] Phase transformations and their hysteresis under impact compression are analyzed in the temperature-pressure plane with the aid of phase equilibrium diagrams, the hysteresis line intersecting the pressure axis in the case of martensitic transformation and not intersecting it in the case of diffusive transformation. A substance whose phases with p6/mmc and with Fd3m or F43m structures remain stable within some region of the p-T diagram is selected as model, assuming also that the zone of static hysteresis is completely contained within the zone of dynamic hysteresis. The analysis is based on available theoretical and experimental data, the latter pertaining to compression of aluminum and titanium by shock waves. Into account are taken dependence of the degree of transformation on the initial temperature, buildup and decay of temperature gradients during compression, and distribution of liquid mass and solid mass along the shock wave. The author thanks A. V. Ananin, A. N. Dremin, V. N. Drobyshev, S. V. Pershin, and V. F. Tatsiy for many discussions and helpful comments. Figures 6; references 19: 15 Russian, 4 Western.

UDC 533.95:538.4

Expansion of Materials After Intense Heating in Strong Shock Waves

18620139e Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 25 No 1, Jan-Feb 89 (manuscript received 4 Feb 87) pp 140-142

[Article by M. M. Rusakov and V. N. Nogin, Chelyabinsk]

[Abstract] An experimental study of LiH and tungsten was made concerning their isentropic expansion after intense heating in strong shock waves. Tests with 32.5 km/s shock waves were performed on a 5.5 mm high LiH plug 5 mm in diameter and on a 0.5 mm thick tungsten disk 5 mm in diameter, each carrying a 5.5 mm high paraffin plug on top, in a cylindrical channel 5 mm in diameter and of variable 60-200 mm length filled with xenon, air, or deuterium. The data have been analyzed and evaluated in terms of p-v and p-c_p/c_v curves for each material. These curves reveal an appreciable deviation from adiabatic expansion of an ideal gas with a constant c_p/c_v ratio of 1.67, namely a large dip of the instantaneous effective c_p/c_v ratio after a small peak within the 1-10 kbar pressure range and its subsequent increase. During the initial stage of compression the density of the expanding material was found to decrease much slower than that of an ideal gas, which indicates a possibility of producing dense compacts. Figures 2; tables 1; references 10: 9 Russian, 1 Western.

Acoustoelectromagnetic Solitons in Crystals With Nonlinear Electrostriction

18620151a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 2, 26 Jan 89 (manuscript received 24 Nov 88) pp 61-65

[Article by G. N. Burlak, Kiev State University imeni T. G. Shevchenko]

[Abstract] The possibility of envelope solitons forming upon nonlinear interaction of electromagnetic and

acoustic waves in anisotropic crystals with quadratically nonlinear electrostriction is demonstrated theoretically, a pair of parallel ordinary and extraordinary longitudinal electromagnetic waves and a transverse acoustic wave being considered in a uniaxial crystals with 3m symmetry. Analysis and calculations based on the equation of wave kinetics for the moduli of slowly varying complex amplitudes reveal both amplification and compression of acoustoelectromagnetic envelope solitons in the process of their evolution, their velocity being of the same order of magnitude as the velocity of sound. This process was observed in crystals with trigonal symmetry, specifically in $LiNbO_3$ crystals, but numerical estimates were made for a $BaTiO_3$ single crystal with a much larger dielectric constant and with the appropriate symmetry at temperatures below -90 °C. Figures 2; references 5: Russian.

Theoretical Strength of a Crystal in Shock-Wave Loading Conditions

18620145a Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian
Vol 24 No 6, Nov-Dec 88 pp 106-111

[Article by M. A. Mogilevskiy, I. O. Mynkin]

[Abstract] This study carries out calculations for a plane densely-packed copper lattice with the pair potential of atomic interaction in the form of a piecewise power function. Interactions up through the third neighbor were accounted for. The coefficients were selected to satisfy the following experimental properties of copper: zero pressure in a cold lattice with an equilibrium distance between the nearest neighbors, points on the zero compression isotherm: 30 and 50 GPa, bulk modulus: 150 GPa, stacking fault energy: 45 mJ per m^2 and effective sublimation energy: 1.75 eV. A crystalline lattice all of whose atoms are located at the crystallographic sites was investigated. The lattice was then subjected to uniform shear, distension, or compression, and hence all sites are identical. This experimental setup is then used to investigate the effect of uniform pressure on the theoretical shear strength, the effect of temperature on theoretical strength and the influence of point defects on the flow stress of a dislocation-free crystal under uniaxial compression. It was determined that the theoretical strength of a cold crystalline lattice is determined by the form the stress state. Under strong one-dimensional compression a copper lattice will lose stability only in the megabar pressure range at the wavefront of the shock wave. The Cowan estimate of wave intensity producing a "supercritical shear" is substantially lower. At zero temperature the theoretical strength of a dislocation-free crystal in given stress conditions should be defined as the stress at which there is loss of lattice stability in the vicinity of the most effective thermodynamically-equilibrium complex of point defects.

Structural Changes in Amorphous Metallic Alloys Under Shock Wave Loading

18620145b Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian
Vol 24 No 6, Nov-Dec 88 pp 111-115

[Article by V. I. Kirko, A. A. Kuzovnikov]

[Abstract] This study examines the possible structural changes occurring in amorphous metallic alloys under shock wave loading based on an analysis of existing experimental data. These data are derived from nuclear magnetic resonance and the EXAFS technique. Previous studies have determined that shock wave loading of amorphous metallic alloys can cause structural disorder in local regions with elevated free bulk concentrations on scales of approximately 10^2 angstroms and structural disorder in regions of elevated plastic flow. This study reports that a comprehensive survey of the literature indicates that shock wave loading will produce structural changes in amorphous metallic alloys. Structural ordering of such alloys will occur in regions of elevated free bulk concentrations on submicron scales of approximately 10^2-10^3 angstroms. The disorder process will occur simultaneously in the region under heterogeneous deformation due to dilatation in the localized adiabatic shear bands generated at the micron-scale irregularities in the surface relief.

Molecular-Dynamic Analysis of the Atomic Structure of a Material Under Shock Wave Propagation Loading

18620145c Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian
Vol 24 No 6, Nov-Dec 88 pp 124-127

[Article by S. Yu. Korostelev, S. G. Psakhye, V. Ye. Panin]

[Abstract] This study carries out an analysis of the behavior of an atomic subsystem from shock wave propagation for the case of a shock wave of irregular wavefront. α-Fe crystallite as a rectangular configuration in the (110) plane containing approximately 10^4 atoms was used for the modeling process. The shock wave was initiated in the (110) direction. The irregular shock wavefront was generated by two methods: initiation of the shock wave locally rather than along the entire boundary plane and by distorting the shock wave front by interaction with an inclusion of 200 atoms of mass $m = 2m_0$ (m_0 is the atomic mass of the matrix). The study also calculates the kinetic energy distribution in the direction of shock wave propagation. The calculations are identical to those obtained previously, showing that a stable kinetic energy peak appears at the trailing edge of the shock wave. A so-called "unstable" region characterized by rising average kinetic energy then forms. The radial distribution function is calculated at various times in the present study to analyze atomic structural changes in the various crystallite regions. It is clear that as the shock wave propagates the delta-peaks of the RDF

characteristic of the crystal wash out in the region under analysis. The radial distribution function is then nearly entirely restored although the peaks "shift" relative to an ideal structure due to the nature of loading. Clearly the irregular wavefront of the shock wave causes the radial distribution function of the atoms to lose its discrete and characteristic form for the crystal and to become irregular.

Radiation From Shock-Compressed Halogen Derivatives of Methane

18620145d Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian
Vol 24 No 6, Nov-Dec 88 pp 127-134

[Article by M. F. Gogulya, I. M. Voskoboynikov]

[Abstract] This study analyzes the thermal radiation from halogen derivatives of methane, including $CHCl_3$, $CHBr_3$, CH_2Cl_2, CH_2Br_2, and CH_2I_2. The temperature at the leading edge of the shock wave propagating through the test material was determined optically based on a comparison of the radiation emitted by the matter and by a reference light source. FEU-119 and FEU-92 photoelectron multipliers were used as the radiation detectors while the changes in luminous flux intensity were recorded by the OK-33M oscilloscope. The radiation brightness was recorded at two effective wavelengths of λ = 420 and 720 nm (in the blue and red portions of the spectrum). This experimental setup is used to produce the dependences of the shock compression temperatures on the shock wave intensities for $CHCl_3$, $CHBr_3$, CH_2Cl_2, CH_2Br_2, and CH_2I_2. Plots of the shock compression temperatures of the halogen derivatives of methane on pressure are also given; these show a weaker temperature growth. The study suggests that this provides evidence of transformations occurring within the halogen derivatives accompanied by energy absorption. Finally, the study concludes that the transformations of the halogen derivatives of methane occur from thermal decay. Certain unresolved issues still exist, since at present it is not possible to attribute the anomalous variations in shock compression temperatures to the onset and completion of total decay nor the onset and realization of a separate decay stage.

Efficient Excitation of Rayleigh Waves by Weak Shock Wave Triggered by Spark Discharge in Air

18620144a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian
Vol 14 No 21, 12 Nov 88 (manuscript received 11 Jul 88) pp 1945-1949

[Article by S. V. Korolev and V. V. Krylov, Moscow State University imeni M. V. Lomonosov]

[Abstract] An experiment with excitation of Rayleigh surface waves by a weak air shock wave resulting from a spark discharge has demonstrated that the efficiency of this process can be maximized by full utilization of its energy, most expediently with aid of a focusing sound reflector. Concave spherical lenses made of optical glass with radii of 25-62 mm and apertures of 35-71 mm were used as such a reflector, with the spark gap between electrodes located at some distance from the surface. For an evaluation of this method, pulse delays owing to multiple reflections were measured in addition to the recording of oscillograms of Rayleigh waves riding on incident and reflected acoustic rays in air. The results, supported by elementary geometrical analysis, indicate that use of a focusing reflector can make spark excitation of Rayleigh waves more energy efficient by at least two orders of magnitude. The authors thank O. V. Rudenko for helpful comments. Figures 2; references 11: 8 Russian, 3 Western.

UDC 534.222.2

Structure of Shock Wavefront in Metals

18620154a Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 26 No 6, Nov-Dec 88 (manuscript received 7 Jan 88) pp 1220-1221

[Article by O. R. Osipova, G. I. Kanel, and S. V. Razorenov, Institute of Chemical Physics, USSR Academy of Sciences]

[Abstract] An experimental study of shock waves in metals involving measurement of the strain rate behind the wavefront with a laser interferometer confirms earlier evidence of a power-law dependence of that strain rate in the plastic range on the amplitude of the shock wave, the power exponent in this relation being close to 4. This applies not only to shock waves in Al, Bi, Cu, U, alpha-Fe, and stainless steels but also to alpha(b.c.c.)-to-epsilon(c.p.h.) phase transition waves in iron under pressures about 13 GPa. The results of these measurements indicate also that, inasmuch as the maximum shearing stress at the shock wavefront is proportional to its amplitude squared, the absolute viscosity (derivative of shearing stress with respect to strain rate) of metals at strain rates above 10^5 s^{-1} is inversely proportional to the stress. This contradicts theoretical data indicating a nonmonotonically stress-dependent deformation resistance of metals. Figures 2; tables 1; references 9: 7 Russian, 2 Western.

UDC 621.375.8

Use of Acoustooptic Filters in Automatic Emission Spectrum Analyzers

18620152a Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 50 No 2, Feb 88 (manuscript received 8 Jan 88) pp 268-275

[Article by I. V. Galishnikov, L. K. Mikhaylov, Ye. V. Popova, S. L. Seregin, O. B. Cherednichenko, and P. I. Shnitser]

[Abstract] The process of recording a line spectrum of weak monochromatic emission against a background of intense gas-discharge glow and spectral lines from other

emission sources is analyzed on the model of a scanning spectrometer with an acoustooptic filter capable of extracting a signal submerged in noise in both electrical and optical channels, as a basis for automating such an instrument with the aid of an Elektronika-60 microcomputer including appropriate interface and peripheral equipment. The spectrometer proper contains, in addition to the computer-controlled filter, also a photocurrent detector, a photomultiplier with power supply, a scanning frequency synthesizer, and a high-frequency amplifier. The acoustooptic filter, with an angular aperture 1:15 and a linear aperture 0.6 cm square, has a spectral resolution of 0.1-0.2 nm and operates with control voltages of up to 10 V covering the 80-130 MHz frequency range. Figures 3; references 5: 3 Russian, 2 Western (both in Russian translation).

UDC 621.373.826.038.823

Kinetic Model of Active Medium of XeC1-Laser With Electron-Beam Pumping

18620150b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 16 No 2, Feb 89 (manuscript received 21 Apr 88) pp 278-280

[Article by A. M. Boychenko, V. I. Derzhnev, A. G. Zhidkov, and S. I. Yakovlenko, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] A rather comprehensive kinetic model of a XeC1-laser with various buffer gases has been constructed with the aid of Plazer-1 special-purpose computer programs, for calculation of its performance characteristics: dependence of efficiency and output energy density on Xe and HC1 partial pressures as well as on concentration and pressure of the buffer gas. Calculations were made for such a laser pumped by electron beams of microsecond duration with a power density of 100 kW/cm^2, three gases (He, Ne, Ar) being considered as buffer, in a cavity between a first mirror with a unity or 0.998 reflection coefficient and an exit mirror with an 0.15 or 0.26 reflection coefficient. The calculations, based on the "zero-dimensional problem" model, overestimate the performance characteristics but reveal more distinctly various features of relaxation kinetics in the active medium. Figures 3; tables 1; references 17: 7 Russian, 10 Western (2 in Russian translation).

UDC 621.373.826:681.7.068

Efficient Compression of High-Energy Laser Pulses in Fiber-Optic Compressor Gratings

18620150c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 16 No 2, Feb 89 (manuscript received 7 Apr 88) pp 298-300

[Article by Ye. M. Dianov, L. M. Ivanov, P. V. Mamyshev, and A. M. Prokhorov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Compression of laser pulses by phase self-modulation in a nonlinear fiber-optic light guide is considered, frequency modulation of pulses being linearized and compression of pulses thus being facilitated by phase self-modulation combined with positive dispersion group velocity. It however remains necessary, especially for compression of high-energy pulses, to suppress stimulated Raman scattering which limits pulse compression in optical fibers by depleting the pump pulse and distorting its frequency modulation. Dispersionless phase self-modulation attainable in shorter than optimum-length optical fibers removes this limitation, but highly compressed pulses appear with a wide pedestal containing a large fraction of the total pulse energy. Utilization of the nonlinear birefringence in optical fibers along with phase self-modulation is proposed for suppression of this pedestal and thus efficient compression of high-energy pulses, the feasibility of this method having been demonstrated both theoretically and experimentally. The experimental apparatus included a quarter-wavelength plate behind the fiber exit for compensation of the linear birefringence and then a polarizer which reflected low-intensity radiation while passing only nonlinearly double-refracted radiation. Theoretical calculations have yielded the envelopes and the spectra of incident, reflected, and transmitted pulses. Pulses of 50 ps duration carrying 350 kW of 1,064 nm radiation from YAG:Nd^{3plus}-laser with active mode locking and Q-switching were compressed to 1.7 ps duration in a 30 cm long single-mode optical fiber with a core of quartz glass 0.013 mm in diameter. Figures 3; references 12: 3 Russian, 9 Western.

UDC 621.373.836.038.825.2

Mode Locking By Colliding Pulses in $YA10_3$:Nd^{3+}-Laser

18620150d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 16 No 2, Feb 89 (manuscript received 14 Apr 88) pp 300-305

[Article by Sh. Burdulis, G. Sinkyavichyus, V. Sirutkaytis, and R. Stakvilyavichyus, Vilnyus State University imeni V. Kapsukas]

[Abstract] Mode locking by colliding pulses is considered as an effective method of generating ultrashort laser pulses for laser spectroscopy, antiresonant annular reflector with the absorber cell in the center replacing the conventional high reflectance first mirror in contact with the absorber cell. The advantages of this arrangement have become evident and the operating mechanisms have been revealed in a comparative experiment with a $YA10_3$:Nd^{3+}-laser and either a high-reflectance mirror forming a linear cavity an antiresonant reflector. Not only the same active medium but also the same saturable absorber, ethanol solution of 3274u dye, were use in each case. The advantages of an antiresonant reflector are indicated by the dependence of the pulse duration on the ratio of laser beam cross-sections in the absorber and in the active medium respectively, pulses of 10 ps duration having been obtained with a natural 1:1 ratio of the two cross-sections with the antiresonant reflector while a 2.1 times larger laser beam cross-section in the absorber cell and thus insertion of a telescope was required for generating such short pulses in the linear cavity. The energy of a pulse train and its variance were also measured and the number of pulses in a train was counted, with a telescope in the linear cavity but not with the antiresonant reflector. Trains of 4-5 pulses with a total energy of 6 mJ, the variance not exceeding 5 percent, were obtained in the latter case, but with a different than in the linear cavity ratio of radiation intensities in the absorber cell and in the active medium. Figures 2; references 8: 2 Russian, 6 Western.

UDC 621.373.826.038.823

Kinetics of Processes in CO_2 Waveguide Laser With Control of Emission Pulseform

18620150a Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 2, Feb 89 (manuscript received 6 Oct 87) pp 195-204

[Article by A. S. Biryukov, N. I. Lipatov, P. P. Pashinin, and A. M. Prokhorov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Processes in periodically pulsed waveguide gas lasers, specifically CO_2-lasers, are analyzed by numerical methods for possibilities of attaining meander-form emission in pulses of 0.010.0.050 ms duration at repetition rates of 15-50 kHz. Numerical simulator is based on a CO_2-laser with excitation by externally maintained capillary discharge in a 1:1.5:7.5 CO_2:N_2:He gas mixture under a pressure of 160 mm Hg inside a 250 mm long guide channel 3 mm in diameter. The wall of this channel is made of BeO ceramic so as to ensure that its inside surface remains always at room temperature while the outer wall of the waveguide is being cooled. The cavity is formed by two plane mirrors close to the respective ends of the waveguide, the first mirror with a 0.98 reflection coefficient and the exit mirror with a reflection coefficient arbitrarily varied as a function of time but with a constant 0.02 absorption coefficient. The mathematical model for numerical analysis is a system of three of equations of kinetics for the given molecular nonequilibrium mixture, the variables in these equations determining the degree of vibrational excitation of the active medium and the system being closed by supplementary expressions for several parameters such as electron temperature, electron concentration, gas temperature, and radiation intensity in the cavity. Analysis of the solution on the basis of known relations and available numerical data indicates that regulation of the reflection coefficient at the exit mirror and thus of the cavity Q-factor in synchronism with preionization pulses for the gas provides adequate means of controlling the form of laser emission pulses, the specific requirements of meander-form emission being best satisfied by letting this reflection coefficient parabolically increase and then decrease during the meander half-periods and making the exit mirror fully transparent between excitation pulses. Figures 3; references 17: 11 Russian, 6 Western.

Mutual Focusing of Electron Beam and Electromagnetic Wave in Free-Electron Lasers

18620151a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 2, 26 Jan 89 (manuscript received 22 Nov 88) pp 1-4

[Article by V. G. Baryshevskiy, I. Ya. Dubovskaya, and O. N. Metelitsa, Scientific Research Institute of Nuclear Problems at Belorussian State University imeni V. I. Lenin]

[Abstract] It is demonstrated theoretically that coherent interaction of the electron beam and the electromagnetic wave in a free-electron laser results in mutual focusing of both, the wave being refracted by the beam while a net focusing of electrons by a mean effective force toward the wave crest takes place. The supporting analysis is based on the Kapitsa-Landau method of calculating the electron ballistics in a helical magnetic field as that of a helical wiggler. References 9: 4 Russian, 5 Western.

UDC 621.373

Quasi-Continuous-Wave Al_2O_3:Ti^{3+} Power Laser Pumped by Cu-Vapor Laser and Tunable Over 680-960 nm Range of Spectrum

18620188 Tomsk OPTIKA ATMOSFERY in Russian Vol 1 No 12, Dec 88 (manuscript received 21 Oct 88) pp 87-93

[Article by S. G. Bartoshevich, V. D. Burlakov, V. V. Zuyev, Yu. P. Polunin, G. A. Skripko, and V. S. Urbanovich, Mezhotraslev Institute of Skills Improvement at Belorussian Polytechnic Institute, Minsk, and Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] An experimental study was made concerning the feasibility of atmospheric sounding with a quasi-continuous-wave tunable Al_2O_3:Ti^{3+}-laser pumped by a Cu-vapor laser, an Al_2O_3:Ti^{3+}-laser being tunable from red to near-infrared wavelengths and having a high efficiency determined by the Stokes shift only in addition to other advantages over dye lasers and other crystals with color centers. Selection of a Cu-vapor laser for pumping was dictated by its excellent beam and pulse characteristics. The pumping laser was a master oscillator and power amplifier set, gas-discharge tubes made of BeO being used for both. The master oscillator with a plane exit mirror inclined at 45 deg and having a center hole, followed by a polarizing Glan prism, were placed inside an unstable cavity between two concave spherical mirrors. The exit mirror passed radiation from the master oscillator through a space filter-collimator to the power amplifier inside a cavity between a rotating plane mirror and a spectrum splitter, the filter-collimator consisting of two confocal mirrors and a diaphragm in the plane of their common focus. The active medium of the main laser, an Al_2O_3 crystal containing 0.1-0.3 pct Ti and cut at a Brewster angle, absorbed about 98 pct of the pumping 510.6 nm radiation and about 60 pct of the pumping 578.2 nm radiation. It was placed between two focusing lenses which formed a concentric cavity, inside a nonselective cavity formed by a dummy-mirror plate on the pump side and a plane exit mirror. Various exit mirrors were used so as to vary the reflection coefficient over the 0.50-0.85 range. Radiation emitted by this Al_2O_3:Ti^{3+}-laser could also be passed directly without an exit mirror to a dispersive selector consisting of a chromatic telescope formed by two prisms, a Fabry-Perot interferometer, and a diffraction grating. Radiation within a 1-2 pm wide line tunable over the 680-960 nm range of the spectrum and with an average power of 2.6 W could be extracted from this laser at an efficiency of

8-12 pct, in a beam with hardly more than diffraction divergence. The minimum attainable line width was 0.3 pm. Minimization of passive losses should raise the efficiency to as high as 25 pct and adding an $Al_2O_3:Ti^{3+}$ crystal as amplifier should raise the efficiency even further. The authors thank V. I. Voronov, A. Ye. Kirillov, and V. L. Kruglyakov for technical assistance. Figures 5; references 7: 4 Russian, 3 Western.

UDC621.373.826.036.823

Stability and Characteristics of Striae Locking in Cataphoretic Lasers and Prospects of Their Operation in This Mode

18620143a Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 2 Nov 87) pp 2415-2420

[Article by V. A. Vaskov, S. A. Gonchukov, Ye. V. Kurbatov, and Ye. D. Protsenko, Moscow Institute of Engineering Physics]

[Abstract] Considering that the principal source of noise in cataphoretic metal vapor lasers is striation caused by oscillations of the discharge plasma and that attenuation of the noise level requires elimination of beats, the effectiveness of locking the striae at a single frequency is evaluated on the basis of experimental data and theoretical analysis. The experiment was performed on a Cd-vapor laser with He as buffer gas emitting 440 nm violet radiation, such a laser being usually too noisy for many applications. Measurements of output power and relative noise level have revealed a strong dependence of both on the modulation frequency of the discharge current, on the pressure of the gas mixture, and on the dimensions of the capillary discharge tube, its dimensions to a large extent determining the pressure distribution. Discharge tubes up to 3.0 mm in diameter and 20-80 cm long were used, with He pressure varied over the 4.3-7.3 mm Hg range at a Cd-vapor pressure of 0.003 mm Hg or with the Cd-vapor pressure varied over the 0.0015-0.0040 mm Hg range at a He pressure of 6 mm Hg. Application of a transverse magnetic field of 500 Oe with the intensity vector in the plane of laser beam polarization in an experiment with He-Zn laser was found to appreciably boost the output power. The results indicate the feasibility of appreciably lowering the noise level without lowering the output power by optimizing the design of the active medium and striae locking at the optimum frequency. Figures 4; references 10: 6 Russian, 4 Western.

UDC 621.373.826.038.825.4

New Evidence About Dynamics and Spectrum of Picosecond Three- Component Injection Laser

18620143b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 13 Aug 87) pp 2421-2426

[Article by P. P. Vasilyev and I. S. Goldobin, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] An experiment with modified passive Q-switching of AlGaAs/GaAs/AlGaAs double-hetero junction lasers has yielded new data pertaining to their dynamics and emission spectrum, the Q-switching having been designed to improve the characteristics of emitted ultrashort pulse in the picosecond range. This was achieved by subdividing the laser structure into three regions, two lateral ones amplifying the light and a saturable absorber between them. The amplifiers were pumped each with different positive pulses of 2-100 ns duration and 0.3-3 combined amplitude, while a constant blocking voltage of 1(1-20) V was applied to the absorber. Pulse repetition rates up to 18.5 GHz but not lower than 0.7-0.8 GHz were recorded although theoretically lower ones down to zero could have been expected. Pumping with triangular pulses having a rise time of 400 ps and a width of 5 ns at half-amplitude level made it possible to vary the repetition rate of emission pulses by varying the voltage at the absorber only. The repetition rate was found to change jumpwise without any transient process. The emission band was found to be very wide, up to 20 nm about the 850 nm wavelength, sometimes becoming alternately "narrower" and "wider" within a typically 100 ps pulse. A key factor in this behavior is evidently the strong electrical coupling between the nonlinear absorber and both amplifiers, the 10^3-10^4 V/cm strong electric field between them facilitating drift of excited charge carriers from the absorber to the amplifiers. Figures 7; references 11: 9 Russian, 2 Western.

UDC 621.373.826.038.825

Amplitude-Frequency Characteristics of Rotating Solid-State Ring Laser With Nonsteady Acoustooptical Mode Locking

18620143c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 13 Aug 87) pp 2434-2439

[Article by N. V. Kvartsov, S. V. Parfenov, and A. N. Shelayev, Scientific Research Institute of Nuclear Physics at Moscow State University imeni M. V. Lomonosov]

[Abstract] An experimental study of a rotating YAG:Nd^{3+} ring laser was made, for the first time with nonsteady acoustooptical mode locking at a frequency varying over the 10-100 kHz range and attendant cophasal intensity modulation of counterpropagating ultrashort pulses at the locking frequency and its multiples. The laser with a three-mirror or four-mirror cavity was mounted on a turntable and rotated while being pumped with continuous radiation from a DNP-6/90 Xe-arc lamp so that the maximum difference between the repetition rates of counterpropagating pulses could reach 3 MHz. The acoustooptic mode locker consisted of a $LiNbO_3$ piezoelectric crystal with a 36 ° Y-cut and a natural frequency of 125 MHz serving as acoustic transmitter and a sound guide made of fused quartz in which nearly standing acoustic waves were excited. This device modulated losses in the laser at a beat frequency of 250 MHz in the Bragg diffraction mode. Measurement of the

time shift of pulses in each of the two counterpropagating waves relative to the instant of minimum loss within a modulation cycle, during the period of increasing difference between the natural frequencies of the cavity for counterpropagating waves, has yielded the dependence of these time shifts on the modulation frequency and on the rotation speed. The results indicate the possibility of eliminating competitive suppression of one of the counterpropagating pulse waves by rotation of the laser set, also of measuring the speed by splitting the frequencies of their cophasal intensity modulation and the frequencies of relaxation oscillations during mode locking. Figures 4; references 16: 14 Russian, 2 Western.

UDC 621.373.826.038.825.3

Generation of Nanosecond and Microsecond Pulses in Nd-Laser With Negative Feedback

18620143d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 17 Feb 88) pp 2471-2473

[Article by N. S. Vorobyev, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Pulse duration regulation over the 50-1000 ns range in a Nd-glass laser was achieved with the aid of electrooptic negative feedback. The cavity was formed by two spherical mirrors, one with 50 pct reflectance having a 10 m radius wand with 60 pct reflectance having a 2.5 m radius. A diaphragme between the first mirror and the active medium facilitated operation in the fundamental transverse mode. The active medium, a rod of GLS22 neodymium glass, was pumped by two IFP- 5000 flash lamps and its radiation was linearly polarized by a crystal of Iceland spar. Electrooptic feedback was provided through a $LiNbO_3$ crystal 32 mm long with a 4 mm square cross-section, under a half-wave voltage of 1.2 kV for the 1,060 nm radiation line, and a photomultiplier. The pulse duration could be smoothly regulated by smoothly varying the feedback factor. Pulses of a bell shape without intensity fluctuations were generated, with an energy of 0.15-0.25 mJ in the free-running mode and of 3-5 mJ when of 50 ns duration. The author thanks V. Ye. Postovalov and N. A. Tarasova for assisting in the experiment, M. Ya. Shchelev for interest and helpful discussions. Figures 3; references 12: 10 Russian, 2 Western.

UDC 621.373.826.038.823

Pumping Gase Laser With High-Intensity Ion Beam in Accelerator With Inductive Energy Storage and Plasma-Type Current Chopper

18620143e Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 8 Jun 88) pp 2502-2504

[Article by M. S. Arteyev, B. M. Kovalchuk, V. A. Kokshenev, S. S. Sulakshin, and V. F. Tarasenko, Scientific Research Institute of Nuclear Physics at Tomsk Polytechnic Institute imeni S. M. Kirov]

[Abstract] Pumping an Ar-N_2 laser with an ion beam in an accelerator was tried in the MARINA facility, the latter including a 0.0023 mH inductive energy storage loaded by a 0.0008 mH inductance between a generator of 720 kV voltage pulses and a current chopper. The current chopper operated by the mechanism of plasma injection and plasma rupture resulting in formation of an ion diode and of a 1.5-2 MeV ion beam with a current density of 8 A/cm^2 in pulses of 40 ns width at half-amplitude level. The active medium in a 30 cm long cell was placed between two plane mirrors, one aluminum-coated for high reflectance and an exit mirror with 8 pct reflectance, forming a 35 cm long cavity. Measurements were made with a quartz spectrograph and a collimated Faraday cylinder. Radiation emission from a 4:1 Ar:N_2 mixture was obtained at 337.1 nm, 357.7 nm, and 380.5 nm wavelengths, corresponding to three transitions in the second positive system of N_2-molecules. Figures 2; references 8: Russian.

UDC 621.373.826.038.823

Use of Open Cavity for Parametric Free-Electron Laser

18620143f Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received, after completion, 17 Mar 88) pp 2530-2532

[Article by V. I. Alekseyev, Ye. G. Bessonov, and A. V. Serov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Use of an open cavity for a parametric free-electron laser is considered and, on the basis of H. Motz's theory of such lasers, its performance characteristics with an open cavity are calculated in the approximation that all wave field and electron beam parameters remain constant during passage the laser space. These calculations reveal how the intensity of emitted radiation and the degree of its monochromaticity depend on wiggler, electron beam, and cavity parameters such as the distance between the two mirrors. The results agree sufficiently well with experimental data. Figures 1; references 10: 6 Russian, 4 Western (1 in Russian translation).

UDC 621.373.826:533.9

Evaporation of Target and Formation of Absorption Waves in Air Under Ultraviolet Laser Radiation

18620143g Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 15 No 12, Dec 88 (manuscript received 7 Aug 87) pp 2568-2574

[Article by Ye. O. Danilov, V. A. Danilychev, V. A. Dolgikh, V. D. Zvorykin, M. Ye. Zemskov, O. M. Kerimov, G. Ye. Metreveli, and G. Yu. Tamanyan, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Irradiation of graphite by a KrF-laser at the 248 nm wavelength in air is analyzed on the basis of

experimental data and applicable theory. In the experiment triangular pulses of less than 0.3 J energy and of 500 ns duration with 100 ns rise time were focused through a lens with a 400 mm focal length on a spot with an area of 20 mm^2, inside a hermetic chamber where the pressure was varied over the 0.1-760 mm Hg range. The radiation power density at the peak of a pulse was 0.6-1.1 GW/cm^2 and thus much higher than the 30 MW/cm^2 threshold for vaporization of graphite. The characteristics of graphite vapor thus produced are calculated on the basis of applicable thermodynamic relations, taking into account its ionization in the presence of NO, N_2, CN molecules and CO^{plus} ions in ionized air but in vacuum. Waves of hot air forming upon absorption of laser radiation are considered next, assuming that under atmospheric pressure their propagation follows light-activated detomation in conformance with Jouguet's rule and that the radiation intensity threshold for their sustenance is much lower for a wide laser beam with negligible lateral gas expansion. Interaction of a graphite target in air with radiation pulses from a KrF-laser evidently follows a different pattern than its interaction with radiation pulses from a CO_2-laser. Figures 3; tables 2; references 20: 17 Russian, 3 Western.

Phase Self-Conjugation of CO_2-Laser Radiation During Four-Wave Interaction

18620149a Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 22, 26 Nov 88 (manuscript received 21 Mar 88) pp 2028-2032

[Article by A. A. Betin, K. V. Yergakov, and O. V. Mitropolskiy, Institute of Applied Physics, USSR Academy of Sciences, Gorkiy]

[Abstract] Formation of a self-pumping mirror for pulsed CO_2-laser radiation having been realized experimentally during four-wave interaction with feedback in CCl_4 as nonlinear absorbent fluid medium and SF_6 as resonant gaseous medium, phase self-conjugation of pulsed CO_2-laser radiation was realized by this method in a subsequent experiment. This experiment was set up according to theoretically established requirements, without and with a NaCl phase plate in front of the CCl_4 cell. The spatial structure, a nonuniform one, of radiation emitted by a CO_2-laser under these conditions was photographed concurrently with measurements of its energy characteristics in the direction of the propagating signal wave and in the direction of the counter-propagating wave. The results not only confirm the effectiveness of four-wave interaction with feedback but also reveal its adaptability to phase nonuniformity in the feedback loop. Figures 2; references 6: Russian.

UDC 532.5:541.15:541.124.13:621.37.32

Numerical Simulation of Natural Convection of Compressible Gas Heated by Laser

18620154b Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 26 No 6, Nov-Dec 88 (manuscript received 2 Jun 87) pp 1195-1202

[Article by S. V. Kapitskiy, V. I. Mashendzhinov, D. A. Nikuln, and V. N. Semenov, Scientific-Industrial Department, State Institute of Applied Chemistry, Leningrad]

[Abstract] In connection with local laser heating of gases for study of chemical reactions and their kinetics by the method of homogeneous laser-induced pyrolysis, mass and heat transfer in a compressible medium is analyzed by numerical simulation of natural convection in a horizontal reactor so as to consider three-dimensional flow. Such a flow inside a horizontal circular cylinder with a laser beam passing through it coaxially and thus constituting an internal heat source is described by a system of three Navier-Stokes equations in the approximation of negligible hydrostatic compressibility, in a dimensionless form including both Grashof and Prandtl numbers. The initial conditions are those of equilibrium, namely zero velocity and dynamic pressure. The boundary conditions are those of adhesion to impermeable walls in terms of zero velocity and of the second kind for the wall temperature. This system of equations has been solved by the Amsden-Harlow SMAC method of numerical simulation, this method having already been tested on nitrogen. The effect of natural convection is evaluated by comparison of the results with those for one-dimensional flow in a vertical cylindrical reactor with a laser beam passing through it coaxially upward. The results were verified experimentally with C_2H_5Cl and CF_3I as reference reactant gases under 500 Pa pressure, SF_6 as sensitizer gas under 400 Pa pressure, and N_2 as buffer gas under 13.3 kPa pressure. Figures 6; tables 1; references 13: 7 Russian, 6 Western (1 in Russian translation).

UDC 532.5:538.4:537.84

Secondary Flow in Channels of Large-Scale MHD-Generators: Nonlinear Effects Under Nominal Operating Conditions

18620154c Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 26 No 6, Nov-Dec 88 (manuscript received 2 Dec 87) pp 1212-1219

[Article by G. Yu. Alekseyev and V. A. Bityurin, Institute of High Temperatures USSR Academy of Sciences]

[Abstract] Turbulence of a compressible gas conducting both heat and electric current in a widening but long MHD-generator channel is analyzed for secondary flow and nonlinearities under nominal electric load and operating conditions, with a small magnetic Reynolds number and a large hydrodynamic Reynolds number. The corresponding system of 10 equations includes 5 parabolized 3-dimensional Navier-Stokes equations, 2 equations of the k-epsilon turbulence model (k- density of turbulence energy, epsilon- density of its dissipation rate), and 3, 2-dimensional (y-z) equations of electrodynamics. The system is closed by temperature and pressure dependence of the thermodynamical properties, the electrophysical properties, and the mass transfer coefficients. An analysis of the solution for a channel with an insulating lateral wall and for a frame channel with a diagonally conducting wall indicates that both have nearly the same integral performance characteristics and most local characteristics, frictional stresses being lower and the flow thus being more stable in a frame channel. The authors thank S.A. Medin for interest and helpful comments. Figures 5; tables 1; references 16: 4 Russian, 12 Western.

The Superstring Z'-Boson At UNK Energies

18620161b Moscow YADERNAYE FIZIKA in Russian Vol 49 No 3, Mar 89 pp 866-875

[Article by V. A. Bednykov, S. G. Kovalenko]

[Abstract] This study analyzes the contribution of the Z'-boson to neutral currents taking into account Z^0-Z'-mixing. The study also obtains quantities derived from the highly-inelastic ν(ν)N-scattering cross-sections that are most sensitive to the Z' contribution. Certain possibilities for direct observation of this particle in neutrino experiments at UNK energies are discussed on the basis of an analysis of these quantities. It is determined that direct observation of the Z'-boson requires improving cross-section measurement accuracy. It is proposed that the statistics from the neutrino experiments at UNK energies be increased by a factor of 10-15 compared to the level achieved on other installations. This can be attained by increasing the neutrino beam energy to 280 GeV for a broad spectrum beam and 300 GeV and 1.1 TeV for a dichromatic beam. The analysis also demonstrates that by comparing the excluded range of variation of N_2 and θ to regions previously excluded on the basis of available data, it becomes clear that a substantial refinement in the values of these important parameters of the superstring phenomenology is possible. Finally the study points out that the conclusions are based on quantities drafted from the ν(ν)N-scattering cross- sections which are more sensitive to the contribution of the Z'-boson.

Degenerate Surfaces and Solitons. The Handle Gluing Operator

18620161c Moscow YADERNAYE FIZIKA in Russian Vol 49 No 3, Mar 89 pp 891-899

[Article by A. A. Gerasimov]

[Abstract] This article considers the final form of operators producing branching points from the degeneration of a hyperelliptical surface for the case of fermions. The analysis begins by discussing fermion fields on hyperelliptical surfaces. It is then demonstrated that the handle gluing operator is reduced to the product of the soliton operators from the degeneration of the handle. A handle gluing operator of the general type is also discussed. The appendix formulates an explicit isomorphism between the "string" (Kack-Frenkel-Segal) and the "soliton" (Lepowsky-Wilson) realizations of the algebra *sl*(2) together with its geometrical interpretation. It is determined that the final form is the creation operator of the soliton-antisoliton pair for the KdV equation. THe handle gluing operator is also represented in another form, i.e., it is rewritten through the fermions; a general handle gluing operator is also derived and reported.

Production of Cumulative Protons During Interaction of Neutrinos and Photoemulsion Nuclei

18620167a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 49 No 4, 25 Feb 89 (manuscript received 6 Jan 89) pp 189-191

[Article by Yu. A. Batusov, O. M. Kuznetsov, V. V. Lyukov, and V. I. Tretyak, Joint Institute of Nuclear Research, Dubna/USSR, A. O. Vaysenberg (deceased), P. A. Gorichev, O. K. Yegorov, E. D. Kolganova, I. V. Makhlyuyeva, Ye. A. Pozharova, V. A. Smirnitskiy, and V. V. Shamanov, Institute of Theoretical and Experimental Physics, Moscow/USSR, A. Jurak, A. Olszewski, B. Wilczynska, H. Wilczynski, B. Wojsek, and W. Wolter, Institute of Nuclear Physics, Krakow/POLAND, M. Ivanova, Plovdiv University, Plovdiv/BULGARIA, Kh. Chernev, Institute of Nuclear Research and Nuclear Power, Sofia/BULGARIA, R. Ammar, D. Connadge, M. I. Dayon, R. Davis, J. Gress, N. Kwak, R. Reimer, and R. Stump, University of Kansas, Lawrence/USA, T. Barnet, S. Krzywdzinski, J. Lord, V. M. Rappoport, and R. Rosenbladt, University of Washington, Seattle/USA, H. Rubin, Illinois Institute of Technology, Chicago/USA, L. Voyvodik and V. Smart, Fermi National Accelerator Laboratory, Batavia/USA, A. Backitch and L. Peek, Sydney University, Sydney/AUSTRALIA]

[Abstract] An experimental study was made within the E-564 scope at the Fermi National Accelerator Laboratory concerning the cumulative effect in interaction of 11-200 GeV neutrinos and photoemulsion nuclei. For the first time the mean yield of cumulative protons was found to decrease as the neutrino energy exceeded 50 GeV, corresponding to a higher than 15 $(GeV/s)^2$ four-momentum squared and 20 GeV transmitted energy. Cumulative protons were extracted from 151 interaction with charged current on the basis of the momentum of g-particles, for a determination of which was measured their relative ionization in the photoemulsion. These and earlier data have been analyzed statistically and evaluated in terms of mean multiplicities of interaction events producing zero protons, one proton, two, and more than two protons respectively, also in terms of their correlation with multiplicities of b, g, and s tracks. The results indicate that the mean multiplicity of relativistic particles N_s does not depend on the presence of cumulative protons and on their number when they are present, while the mean multiplicities of b and g particles are proportional to the number of cumulative protons, also that the mean number of cumulative protons and the four-momentum squared depend on the neutrino energy. The four-momentum squared does not depend on the presence of cumulative protons in events involving 10-30 GeV neutrinos, is larger in the presence than in the absence of cumulative protons in events involving 30-50 GeV neutrinos, and is smaller in the presence than in the absence of cumulative protons in

events involving neutrinos with energy higher than 50 GeV. Tables 3; references 11: 6 Russian, 1 Polish, 4 Western.

UDC 537.52:539.4

Mechanical Instability of Conductor During Electrical Breakdown

18620168 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 304 No 4, Feb 89 (manuscript received 2 Nov 87) pp 845-849

[Article by E. K. Anderzhanov, I. I. Divnov, and N. I. Zotov, Institute of Geophysics imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow]

[Abstract] Electrical breakdown of 0.008-0.050 mm thick aluminum foil on the surface of a dielectric in air was studied in an experiment with a capacitor bank feeding pulses of 3-240 kJ energy into the foil. The data, including photographs, are interpreted theoretically in terms of mechanical instability preceding rupture as a result of rapid intense heating by a heavy current pulse with attendant buildup of internal stresses in a material with structural imperfections. A model of deformation under compressive stresses caused by thermal expansion is constructed, assuming that a flat foil becomes sinusoidally bent prior to rupture without lateral displacement of its edges during the short period of an electric current pulse. Transition from a porous solid to a sheet of liquid droplets corresponds to loss of metallic conductivity. The equations of this model yield the maximum amplitude of foil deflection prior to rupture, then also the breakdown time as a function of that amplitude and of the average specific power liberated. The results of calculations correlate well with experimental data, not only for aluminum foil but also for lead foil tested in an earlier experiment. It is however necessary to take into account dependence of the ratio of maximum deflection amplitude to deflection wavelength on the kinetic energy of particles that are tearing apart. The authors thank Professor V. N. Rodionov for indicating the important role of solid-state stresses in the process of electrical breakdown. Article was presented by Academician M. A. Sadovskiy on 1 October 1987. Figures 3; references 9: 8 Russian, 1 Western (in Russian translation).

Muon Catalysis in Dense Nonhomogeneous Plasma

18620138a Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 95 No 2, Feb 89 (manuscript received 23 Sep 88) pp 458-466

[Article by L. I. Menshikov, Institute of Atomic Energy imeni I. V. Kurchatov, Moscow, and V. A. Shakirov, IATE [Institut Atomnoy i Termoyadernoy Energii], Obninsk]

[Abstract] Muon catalysis in a cold dense deuterium-tritium and thus nonhomogeneous plasma is analyzed, muons sticking to alpha particles by a fusion reaction in mesomolecules and alpha-muon ions becoming stripped of muons during slowdown in the plasma. The probability of stripping and the number of sticking-stripping cycles are estimated, the sticking coefficient having been calculated and stepwise ionization having been taken into account. Theoretical and experimental data on the kinetics of muon catalysis and on the attendant energy balance indicate various possible mechanisms of muon stripping. Conditions for attainment of as many as 300-500 cycles are established on the basis of the temperature dependence of the sticking coefficient and of the cross-section for stripping, both decreasing with rising temperature and the sticking coefficient also decreasing with increasing ratio of the concentration of nuclei in the deuterium-tritium mixture to their concentration in liquid hydrogen. Other ways to increase the number of catalysis cycles worthwhile considering are based on stripping muons in Z-pinches, by escaping electrons in strong electric fields of Z-pinches or by fast electrons and nuclei produced in kink instabilities of Z-pinches. The authors thank R. B. Baksht, S. T. Belyayev, Vit. M. Bystritskiy, Vyach. M. Bystritskiy, Ye. A. Litvinov, V. P. Smirnov, L. N. Somov, B. A. Trubnikov, and A. V. Fedyunin for helpful discussions. Figures 6; references 21: 12 Russian, 9 Western.

Stability of Three-Dimensional Structures and Annihilation of Soliton-Antisoliton Pairs in Discrete Phi^4-Model

18620138b Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 95 No 2, Feb 89 (manuscript received 23 Sep 88) pp 723-731

[Article by V. V. Beloshapkin, G. P. Berman, and A. G. Tretyakov, Institute of Physics imeni L. V. Kirenskiy, Siberian Department, USSR Academy of Sciences]

[Abstract] Stability of soliton configurations and particularly soliton-antisoliton pairs is analyzed on the basis of the discrete phi^4-model, this model being applicable to structural transitions in ferroelectrics and to proton transfer in quasi-one-dimensional chains with hydrogen bonds. The spectrum of small atom vibrations in a soliton chain is found not to contain a phason mode over a wide range of the two-well potential K and thus indicates, unlike the discrete Frenkel-Kontor model, absence of nonpinned soliton structures in the discrete phi^4-model. The effect of thermal and quantum fluctuations on the structural states in this model is evaluated on the basis of the corresponding Hamiltonian in the approximation of a self-consistent phonon field, their effect being to lower the threshold for annihilation of soliton-antisoliton pairs. Dynamically stable equilibrium structures are analyzed on the basis of that Hamiltonian by gradient methods and conditions for pinning a single soliton are established by considering the dependence of the gap in the spectrum of small chain vibrations on the two-well potential K, the gap decreasing fast as that potential increases. The evolution of an equilibrium structure is followed with a stable regular soliton-antisoliton pair selected as initial condition and with dynamic excitations of the chain taken into account. The

system of equations describing equilibrium particles in a chain has been solved in the pseudoharmonic approximation. Numerical analysis of the solution for a chain of 89 particles with zero temperature and 0.5 quantum number has yielded a random soliton structure and indicates that in the discrete phi^4-model there is a critical two-well potential dependent on the soliton density below which a soliton-antisoliton pair becomes dynamically unstable to the extent that exponentially increasing mutual attraction annihilates it. The authors thank A. F. Sadeyev for interest and helpful discussions. Figures 9; references 11: 4 Russian, 7 Western.

Classically Bound State of Two Solitons in Skyrme Model

18620137b Moscow YADERNAYA FIZIKA in Russian Vol 49 No 2, Feb 89 (manuscript received 28 Mar 88) pp 530-536

[Article by B. Ye. Shtern, Institute of Nuclear Research, USSR Academy of Sciences]

[Abstract] Interaction of two Skyrme solitons is treated as a three-dimensional problem of statics, their centers in this formulation being "fixed" at some distance apart. The solution to the corresponding field equations for various distances between those centers is sought by direct minimization of the Lagrangian rather than by solution of Euler's boundary equation. Considering that Skyrme solitons are quite singular, the problem is solved numerically on a grid with a nonuniform distribution of nodes along all three coordinates, dense within the vicinity of topological centers and sparse near the periphery, but consisting of simplexes in the form of almost regular tetrahedra. The results reveal existence of a field configuration for a pair of Skyrme solitons where there is no core so that they freely pass through one another, upon having attracted one another, down to zero distance between their topological centers. Existence of a bound quantum state in such a potential well has not yet been definitely established, solution of this field problem by means of the aforementioned Lagrangian not being possible but likely to yield a Skyrme deuteron. The author thanks S.V. Zenkin and V.B. Kopeliovich for interest and stimulating discussions, also A.K. Skasyrskaya for practical assistance in calculations. Figures 4; references 12: 5 Russian, 7 Western.

Quantum Soliton in Stochastic Field

18620137a Moscow YADERNAYA FIZIKA in Russian Vol 49 No 2, Feb 89 (manuscript received 25 Apr 88) pp 606-611

[Article by I. V. Krive, A. S. Rozhavskiy and Ye. Ye. Tuluzova, Kharkov State University]

[Abstract] The effective potential in a stochastic classical soliton field is calculated, which requires averaging over all realizations of such a field with the energy of the fundamental soliton being a self-averaging quantity. The calculations are based on the Gross-Nevier model, this model possessing the necessary properties such as violation of gamma$_5$-invariance, and adequately representing a Peierls dielectric in the case of a two-component fermion field at the static limit. Two topological solitons are considered, one of fermion mass fluctuations and one of chemical potential fluctuations. For each is calculated the energy in a smooth stochastic field, found to be lower than the rest energy, and the further energy decrement in a delta-correlated Gaussian "white noise" field. References 11: 8 Russian, 3 Western (1 in Russian translation).

Possibility of Detecting Weak Neutral Currents in Cluster-Forming Light Nuclei

18620148b Moscow PISMA V ZHURNAL EKSPERIMENTALONY I TEORETICHESKOY FIZIKI in Russian Vol 48, No 11, 10 Dec 88 (manuscript received 27 Oct 88) pp 573-576

[Article by M.M. Nesterov and I.S. Okunev, Leningrad Institute of Information Science and Automation, USSR Academy of Sciences]

[Abstract] Reactions involving light nuclei are considered, the attendant effects of parity nonconservation not being easy to detect experimentally because of their weakness when involving low-energy neutrons. A possible mechanism of weak interaction in light nuclei in accordance with the cluster model is proposed which allows relating these effects in systems with a low nucleon content to effects in cluster-forming light nuclei. Considering that such reactions in this model admit a rather simple theoretical interpretation and assuming that the effects of parity nonconservation will in this model be stronger than in systems with low nucleon content and ultralow-energy neutrons without necessarily requiring compound resonances of opposite parity, the new mechanism is demonstrated on the 6Li(n,α)t reaction. The latter is used as an example illustrating detection of weak neutral current for estimation of the angular correlation between a polarized neutron colliding with a nucleus in the direction of tritium emission, inasmuch as weak neutral current is the principal contributor to that correlation. The analysis is based on reactions involving 6Li and 7Li in a nucleus excited to up to 25 MeV energy. Calculation of the P-odd correlation with averaged (sigman$_n$,n$_t$) asymmetry is based on the Hamiltonian of weak interactions in the one-boson exchange approximation, with use of constants of weak nucleon-nucleon interaction corresponding to exchanges of pi, rho, and omega bosons. The authors thank V.M. Lobashchev and V.A. Vesna for helpful discussions. References 8: 4 Russian, 4 Western.

Polarized Solitons in Three-Level Media

18620146c Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 94 No 12, Dec 88 (manuscript received 1 Feb 88) pp 61-75

[Article by A. M. Basharov and A. I. Maymistov, Moscow Institute of Engineering Physics]

[Abstract] Propagation and interaction of differently polarized optical ultra-short two-frequency pulses in a

resonant medium consisting of three-level particles are analyzed, taking into account degeneracy of resonance states in various directions of the resultant angular momentum in real media. The polarization model of double resonance is described by the classical Maxwell equations and the quantum-mechanical equations of the density matrix, for the V configuration and for the inverted-V configuration. This model of nonlinear optics reduced to generalized Maxwell-Block equations, for which the Lax representation is found in the form of linear equations integrable by the inverse scattering method and then transformed into Riccati equations in pseudopotentials. A subsequent Baeclund transformation yields polarized simultons, collisions of differently polarized ones then being analyzed with the aid of the scattering matrix. Higher-order laws of conservation and an infinite sequence of momentum integrals are found upon transformation of those linear equations into Riccati matrix equations. References 10: 11 Russian, 9 Western (1 in Russian translation).

UDC 539.2:678.01

Disruptive Fluctuations and Solitons

18620147b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 11, Nov 88 (manuscript received 19 Oct 87 in final version 16 Jun 88) pp 3407-3412

[Article by A. I. Melker, Leningrad Polytechnic Institute imeni M. I. Kalinin, Leningrad]

[Abstract] An equation of motion is derived for a one-dimensional atom chain uniformly deforming under stress on the basis of an anharmonic interatomic interaction potential which admits rupture of the interatomic bond, with two characteristic interatomic distances corresponding to strength-level stress at the inflection point of the potentials a function of that distance and to breaking-length strain respectively. This potential, whether Lennard-Jones or Morse potential, is approximated with a fifth-degree polynomial. The coefficients in the resulting equation are not obtained by series expansion of the specific interaction potential, such an expansion not being reversible for deformation beyond the strain which corresponds to the inflection point for that potential. They are all found to be expressible in terms of four parameters which, in addition to the two strains corresponding to the two characteristic interatomic distances, include the speed of sound and the Grueneisen constant. The steady-state solutions to the equation of motion based on this approximation of the anharmonic interaction potential yield disruptive strain and thus also density fluctuations which, as a function of some space coordinate, become solitons for all modes of chain rupture obtainable in computer-aided numerical experiments. Figures 1; references 10: 7 Russian, 3 Western (2 in Russian translation).

Spin Dependence of Fissionability in Experiments Dealing With Fission of Oriented ^{235}U Nuclei Upon Bombardment by Fast Neutrons

18620169a Moscow YADERNAYA FIZIKA in Russian Vol 48 No 6 (12), Dec 88 (manuscript received 1 Feb 88) pp 1626-1634

[Article by N. N. Gonin, M. A. Guseynov, L. K. Kozlovskiy, N. S. Rabotnov, and D. I. Tambovtsev, Institute of Physics and Power Engineering, Obninsk]

[Abstract] An experimental study of the $^{235}U(n,f)$-reaction involving oriented nuclei was made, in a cryostat containing ^{3}He and ^{4}He. Orientation of nuclei was attained by means of hyperfine electric quadrupole interaction in a mosaic configuration of two 2.5 mm thick $UO_2Rb(NO_3)_3$ single-crystal plates containing natural U and carrying a 1 mg/cm^2 thick layer of isomorphous heavily enriched ^{235}U. Neutrons were produced by (p,n)-reaction with a 0.300-0.400 mA proton current, metallic Li serving as source of 50-200 keV neutrons and Ti ^{3}H serving as source of 300-900 keV neutrons. Four surface-barrier Si-detectors of fission fragments were located at 0, 50 deg, 100 deg, 135 deg angles respectively relative to the direction of the neutron beam coinciding with the C-axis of the nuclei. The uranium target was bombarded with a neutron flux of 10^7 cm^{-2}s^{-1} intensity at temperatures of 0.15 K and 1.1 K, with an inner shield at 15 K and an outer shield at 80 K, the temperatures being measured with carbon thermometers. The data have been evaluated in terms of $DeltaA_0$, $A_2^{nonoriented}$, $DeltaA_2$, $DeltaA_4$ coefficients characterizing the differential cross-section for fission and, on this basis, have yielded the distributions of fissionability with respect to quantum numbers K and J, with a sharp peak corresponding to K approximately equal to J/2. The angular distribution of fission fragments reveals a hexadecapole interaction component and facilitates a precise evaluation of the orientation effect within the total fission cross-section. Figures 4; tables 4; references 22: 15 Russian, 7 Western.

Excitation Energies for Double Isobar-Analog States in Heavy Nuclei

18620169b Moscow YADERNAYA FIZIKA in Russian Vol 48 No 6 (12), Dec 88 (manuscript received 20 Jan 88) pp 1642-1649

[Article by I. V. Poplavskiy, Odessa Institute of Construction Engineering]

[Abstract] By application of the theory of the complex Coulomb interaction constant to isomultiplets, assuming that interaction between two groups of charged particles is describable by the Schroedinger equation for superposition of a variable Coulomb repulsion potential and a constant nuclear attraction potential, an equidistance rule is established for the energies of separation or decay of isomultiplet terms into a charged cluster and daughter isomultiplet terms. This rule, readily satisfied by isomultiplets with mass numbers up to 60, is extrapolated to

heavy nuclei such as $^{197,199}Hg$, ^{205}Pb, $^{205,206,207,208,209}Po$, ^{209}At, ^{238}Pu in which double isobar-analog states exist. The excitation energies for these states are calculated and averaged accordingly, their spread being not larger than 0.4 MeV or 7.5-8 pct and for a ^{208}Po nucleus agreeing closely with the measured 32.29-32.63 MeV. Figures 2; tables 3; references 17: 9 Russian, 8 Western.

Discovery of Exotic Meson With 1.9 GeV Mass Decaying in Eta'Eta Channel

18620169c Moscow YADERNAYA FIZIKA in Russian Vol 48, No 6 (12), Dec 88 (manuscript received 12 Jul 88) pp 1724-1728

[Article by S. V. Donskov, A. V. Inyakin, V. A. Kachanov, A. V. Kulik, A. A. Lednev, Yu. D. Prokoshkin, Yu. V. Rodnov, S. A. Sadovskiy, V. D. Samoylenko, A. V. Singovskiy, V. P. Sugonyayev, G. V. Khaustov, P. M. Shagin, and A. V. Shtannikov, Institute of High-Energy Physics, Serpukhov/USSR, D. Alde and E. A. Knapp, Los Alamos National Laboratory, N.M./USA, F. Binon, K. Brickman, and G. P. Stroot, Universities' Institute of Nuclear Research, Brussels/BELGIUM, M. Guaner and J. P. Penier, Particle Physics Laboratory, Annecy/FRANCE, Joint Serpukhov-CERN Experiment]

[Abstract] A systematic search for exotic neutral mesons decaying into pseudo-scalar mesons has led to discovery of a high-energy one decaying into eta' and eta mesons by predominant exchange with heavy particles and lesser one-pion exchange in the t-channel. Measurements were made with a GAMS-2000 hodoscopic multiphoton spectrometer in the 38 GeV/s pion beam of the Serpukhov pion accelerator. An evaluation of the data indicates an X(1920) meson (1.902-1.932 GeV) with J^{PC} spin parity 0^{2+}, 1^{-+}, or 2^{2+}, with I^G isospin and G-parity O^+, and exponential t-dependence of the differential cross-section. The authors thank N. N. Achasov, V. V. Vladimirskiy, S. S. Gershteyn, A. A. Logunov, and M. S. Shanovits for discussion of the results, and S. N. Grudtsin for assistance in data processing. Figures 5; tables 1; references 22: 10 Russian, 12 Western.

UDC 532.59

Two-Component Solitons in Molecule Chains With Hydrogen Bonds

18620153 Riga IZVESTIYA AKADEMII NAUK LATVIISKOY SSR: SERIYA FIZICHESKIKH I TEKHNICHESKIK NAUK in Russian No 6, Nov-Dec 88 (manuscript received 7 Apr 88) pp 9-15

[Article by V. N. Kshcheyev, Institute of Physics, LaSSR Academy of Sciences]

[Abstract] Excitation of solitons in molecular chains with hydrogen bonds between protons as well as with interaction of protons and heavy ions is analyzed on the basis of a "bottle bottom" proton-proton interaction potential. The possibility of two component phi-kink and psi-bell solitons forming in the proton subsystem and in the heavy-ion subsystem respectively having already been demonstrated, new approximate solutions and also exact solutions to the corresponding system of two already ordinary differential equations with appropriate boundary conditions at infinity are sought without disregarding small oscillations with dispersion in the Hamiltonian of the heavy-ion subsystem and with anharmonicity taken into account. First nonlocalized periodic solutions and then localized soliton solutions are found: the approximate ones appearing in the form of series after the differential functions have been made into polynomials, the exact ones appearing in the form of linear rational fractions with the Weierstrass elliptic function in both numerator and denominator of the periodic solution but absent in the soliton solution. References 14: ;7 Russian, 7 Western.

Experimental Study Concerning Formation of Reflecting Surface of Adaptive Mirror

18620151c Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 2, 26 Jan 89 (manuscript received 10 Nov 88) pp 78-82

[Article by V. V.Apollonov, Ye. A. Ivanova, A. M. Prokhorov, and S.A. Chetkin, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Formation of the reflecting surface of a flexible adaptive mirror by two actuators, one at the center and acting laterally, is analyzed on a semi-empirical basis. Measurements were made with a stroboscopic interferometer using a He-Ne laser and the interferograms were processed so that the surface could be reconstructed from it with a 30 nm precision. Calculations are based on the deformation theory for thin flexible plates, assuming point forces transmitted to the mirror through the actuators. The stress dependence of the mirror response in terms of surface deflection amplitude determined for each actuator separately and covering the 0-3 kHz range of the actuator excitation frequency, indicates that, while the load on the surface may be regarded with neglible error as a static one when it alternates at frequencies up to 100 Hz, an adaptive mirror can compensate phase distortions of light not up to the load frequency which corresponds to first electromechanical or magnetomechanical resonance but only up to the much lower frequency at which the surface formation becomes "dynamic" and thus different than under static conditions. The authors thank V. I. Andryushin, G. A. Zhitomirskiy, V. V. Ostanin, and S. N. Temnov for assistance. Figures 2; references 4: 2 Russian, 2 Western.

Nonlinear Pairing of Light and Dark Optical Solitons

18620148c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 48, No 11, 10 Dec 88 (manuscript received 1 Nov 88) pp 588-592

[Article by V. V. Afanasyev, Ye M. Dianov, A. M. Prokhorov, and V. N. Serkin]

[Abstract] Pairing of two optical solitons, a light one and a dark one, is considered as a mechanism for stabilizing ultrashort high-intensity pulses in a medium with either positive or negative dispersion of group velocity during phase cross-modulation. Theoretical analysis is based on the system of Schroedinger equations for the complex amplitudes of N waves nonresonantly interacting in a cubic nonlinear dispersive medium. In the specific case of two interacting waves the corresponding system of two equations, in a system of coordinates moving with the waves, has three kinds of soliton solutions: 1) light solitons or dark solitons paired, 2) light and dark solitons paired without color inversion, 3) light and dark solitons paired with color inversion. Pairing with color inversion is most practical from the standpoint of realization in single-mode light guides with immunity to sporadic mismatch of pulses. This kind of solution can also lead to the optical "superfluidity" effect. Such a solution was obtained by S. Trillo, S. Wabnitz, and G.I. Stegeman in OPTICS LETTERS, October 1988. Figures 3; references 9: 5 Russian, 4 Western.

Characteristics of Mechanism of Fine-Structure Formation in X-Ray Absorption Spectra of Nonmetals

18620155c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 12, Dec 88 (manuscript received 7 Apr 88, in final version 22 Jul 88) pp 3683-3690

[Article by A.A. Povlychev, A. S. Vinogradov, and S.S. Potapov, Leningrad State University]

[Abstract] The mechanism of fine-structure formation in the x-ray spectra of solids is analyzed by the method of localized orbitals, the characteristics of the mechanism depending on the number of multiple reflections of a photoelectron wave by the atom g-surrounding, on the interaction of transmitted and reflected photoelectron waves, and on the dimensions of the fine-structure region. Each of these three factors is evaluated theoretically as well as on the basis of experimental data for LiF and NaF crystals as typical nonmetals. The atom surrounding potential is calculated by superposition of Heine-Abarenkov pseudopotentials with Madelung correction, disregarding not only inelastic losses of photoelectron energy but also anisotropy of the medium and nonlocalization of the atom surrounding potential. Interaction of photoelectron waves is described by an equation of the Riccati kind and the region of fine-structure formation is treated as a cluster of two cubic surroundings. The dependence of the fine-structure formation mechanism on the energy of a knocked out photoelectron reveals three ranges: distinct resonances at low energy levels, dominant single reflection and refraction at intermediate energy levels, and extended x-ray absorption fine-structure at high energy levels. Spectrum analysis on this basis yields information not only about interatomic distances but also about the atoms themselves. Figures 4; references 15: 6 Russian, 9 Western (2 in Russian translation).

Feasibility of Producing Single-Mode Film Optics

18620156a Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 303 No 4, Nov 88 (manuscript received 22 May 87) pp 847-849

[Article by Ye. D. Kim, Moscow Institute of Electronic Machine Design]

[Abstract] The feasibility of producing single-mode thin films with uniform thickness for integrated optics is demonstrated theoretically on the basis of the Helmholtz equation for the Hertz vector and its solution for a planar dielectric film with equidistant kinks, analysis of experimental data having indicated that attenuation of an optical signal propagating through a film with a nonuniform profile is caused principally by scattering of radiation by

rough edges of the profile. Calculations are made in a cylindrical system of coordinates in which the Hertz vector has only one nonzero component so that it can be reduced to a scalar and all field components of an electromagnetic wave can be expressed in terms of the latter. The results indicate that attenuation of an optical signal in a dielectric film, also in one on a dielectric substrate with a smaller refractive index, can be suppressed by design of the kinky profile. The author thanks A.V. Kalinin for guidance. Article was presented by Academician V.P. Maslov on 7 May 1987. References 7: 4 Russian, 3 Western (1 in Russian translation).

UDC 538.67

New Ferromagnetics Pyrochloric Structure

18620147c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 11, Nov 88 (manuscript received 6 Jun 88) pp 3487-3489

[Article by I. O. Troyanchuk and V. N. Derkachenko, Institute of Solid-State and Semiconductor Physics, BSSR Academy of Sciences, Minsk]

[Abstract] New materials of $A_2^{3+}Mn_2^{4+}O_7$ composition (A- Sc,In,Tb,Ho,Er) with a pyrochloric structure and ferromagnetic properties have been produced by high-pressure-high-temperature solid-phase reaction. Their structure involving the Fd3m space group was identified by x-ray diffraction analysis. The magnetic properties of specimens not containing even traces of other phases were measured with a vibration magnetometer. Noteworthy is a high magnetic moment of the Mn^{4+}- ion, higher than the 2.6 Bohr magnetons in known Mn oxides and ranging from 3.8 in $Sc_2Mn_2O_7$ to 15.9 in $Tb_2Mn_2O_7$. The wide temperature range of their transition to paramagnetic state is most likely attributable to magnetic nonhomogeneity, the $In_2Mn_2O_7$ compound having the highest Curie point: 132 K. The dependence of the specific magnetic moment on the magnetic field intensity at 4.2 K temperature indicates a ferromagnetic ordering of magnetic moments of rare-earth ions in $Tb_2Mn_2O_7$, and $Er_2Mn_2O_7$, the spontaneous magnetic moment of Tb^{3+} and Er^{3+} ions at 4.2 K being approximately 6 and 4.5 Bohr magnetons respectively. Ferromagnetic ordering of the rare-earth sublattice occurs simultaneously with that of the Mn sublattice, which is possible only with strong positive f-d exchange interaction. Figures 2; tables 1; references 4: 2 Russian, 2 Western.

UDC 535:37

Luminescence of Solutions of Complex Organic Compounds Excited by High-Intensity Electron Beam

18620152c Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 50 No 2, Feb 88 (manuscript received 5 Jan 88) pp 232-236

[Article by V. V. Gruzinskiy and A. V. Kukhto]

[Abstract] The fluorescence spectra of several complex organic compounds inorganic solvents covering the 350-650 nm range of wavelengths were recorded upon excitation by an electron beam. These compounds included paraquaterphenyl, BOPBO, DFEB, anthracene, pyrene, fluorenone, coumarins, phthalimides, rhodamine 6G, oxazine 17, DOB, and five complexes with the Eu^{3+}-ion. The principal solvent was toluene, but "intermediate" solvents acetone and benzonitrile as well as benezene, o-xylene,or n-hexane were also used. Excitation was provided by a 150 keV electron beam 2x20 mm^2 in cross-section with a current density up to 2 kA/cm^2, in pulses of 1 ns width at half-amplitude. The fluorescence spectra and the dependence of the glow intensity on the molecule concentration were found to differ somewhat from those corresponding to optical excitation, in the case of anthracene owing to triple-triplet absorption in the case of pyrene owing to intense dimer formation. The authors thank A.V. Dorokhin for helpful discussion, A.Ya. Gorelenko for supplying coumarin 7, oxazine 17, and DOB, and V.S. Khomenko for supplying the complexes with Eu^{3+}-ion. Figures 2; references 12: 5 Russian, 7 Western (1 in Russian translation).

UDC 621.373.826:535.338.334

Doppler-Free Spectroscopy of Optically Dense Gaseous Media by Selective Reflection

18620152d Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 50 No 2, Feb 88 (manuscript received 12 Jan 88) pp 260-263

[Article by V. A. Sautenkov, A. M. Akulshin, and V. L. Velichanskiy]

[Abstract] An experimental study of Doppler-free selective specular reflection for spectroscopy of optically dense gaseous media was made, the absorption line of such a medium at resonance frequency; being close to its emission line. Selective specular reflection was measured for radiation of wavelengths close to that of the ^{133}Cs D_2-line of low-pressure Cs vapor, namely 852 nm with a radiation width of 5.3 MHz. As the source of monochromatic radiation served a 5 mW tunable GaA1As injection laser operating in the continuous-wave mode at room temperature and upon stabilization emitting radiation within a 0.5 MHz frequency band. A holographic total-internal-reflection selector was used for tuning the laser emission with 10 nm precision. A widening of Doppler-free selective-specular-reflection resonances beyond their theoretical uniform width was found to follow an increase of the atom concentration or of the incident radiation intensity, evidently owing to residual Doppler widening and to the finite 0.5 MHz spectral resolution. The frequency dependence of the reflection coefficient and of its first derivative with respect to frequency, that of the latter approaching the Lorentz dispersion curve, was found to change with change in the incident radiation intensity. The authors thank T.A. Vartanyan, A. M. Dykhne, and I.I. Sobelman for interest, G.T. Pak for supplying the laser diodes. Figures 2; references 18: 11 Russian, 7 Western.

UDC 533.93:537.22

Charge Distribution and Correlation Functions Near Boundary of Slightly Nonideal Plasma

18620191b Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 32 No 3, Mar 89 (manuscript received 11 May 87) pp 72-77

[Article by M. M. Shapiro, Yu. V. Tabachnik and N. S. Golosov, Institute of High-Current Electronics, Siberian Department, USSR Academy of sciences, Tomsk branch, and Tomsk State University imeni V. V. Kuybyshev]

[Abstract] Conditions in a classical neutral slightly nonideal equilibrium plasma near an ideal potential wall constituting a plane boundary are considered, with a real plasmoid having a radius of curvature much larger than the Debye shielding length treated as one having a plane surface. The charge distribution functions expressed in terms of corresponding irreducible correlation functions are calculated by appropriate splitting of the system of BBGKI equations into a closed theory of perturbations and taking into account short-range interaction. Both particle-pair and one-particle correlation functions involving the two different kinds of particles are calculated, the one-particle correlation function being corrected for short-range pair correlation. The thus analytically calculated charge density profile within the Debye shielding region is similar to the one numerically evaluated by other authors, short-range correlation adding corrections to the surface thermodynamic functions so that singularities at the boundary are removed. Figures 1; references 12: 9 Russian, 3 Western (1 in Russian translation).

Impact Compression of Porous Iron, Copper, Tungsten, and Their Equation of State Under Terapascal Pressures

18620138c Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 95 No 2, Feb 89 (manuscript received 15 Jun 88) pp 631-641

[Article by R. F. Trunin, A. B. Medvedev, A. I. Funtikov, M. A. Podurets, G. V. Simakov, and A. G. Sevastyanov]

[Abstract] An experimental study was made concerning the compressibility of porous iron, copper, and tungsten, the method of impact compression by means of shock waves being used for its determination. Powder specimens of 98.7 percent pure iron, 99.7 percent pure copper, and 99.8 percent pure tungsten with an up to 0.75 initial porosity were thus compressed under Al or Fe shields. Measurements were made by absolute methods and by relative methods, the former yielding new data on the compressibility of iron and tungsten under pressures up to 700 GPa and for copper under pressures up to 250 GPa. Maximum pressures of 1.4 TPa and 2.2 TPa for compression of iron powder with 2.24 g/cm^3 initial density and of tungsten powder with 6.27 g/cm^3 initial density respectively were attained with extra-strong shock waves. The experimental data have been processed and evaluated in terms of P-V and PV-E equations of state (P—pressure, V—volume, E—energy), with the aid of D-u adiabatic shock velocity diagrams and with reference to available standard data. Figures 6; references 29: 21 Russian, 8 Western (1 in Russian translation).

Oscillations of Radiation Intensity in Impact-Heated Xenon Plasma

18620151d Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 2, 26 Jan 89 (manuscript received 18 Jul 88, in final version 10 Nov 88) pp 15-22

[Article by G. K. Tumakayev and Z. A. Stepanova, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] Experimentally observer anomalous behavior of impact-heated plasmas of monatomic gases (Ar, Xe) behind the shock wavefront, manifesting itself in various forms within various ranges of shock wave velocity, has been classified into four types: 1) fluctuations of plasma radiation emission within the relaxation region occurring within a very narrow range of Mach numbers (7.8-8.8 in Xe, 10.5-11.0 in Ar), 2) weak instabilities evolving within the recombination region and occurring within a wider range of Mach numbers (10-15), 3) changes in the flow pattern above a threshold Mach number (17.4 in Xe, 21 in Ar) when the atom concentration remains constant or decreases with increasing Mach number, 4) stronger instabilities occurring above a threshold Mach number (32 in Ar) when the equilibrium concentration of singly-charged positive ions remains constant or decreases with increasing Mach number. Anomalies of the second type in impact-heated Xe plasma, namely oscillations of the radiation intensity behind the shock wavefront, were studied inside a shock tube over the 10-16.5 range of Mach numbers with the pressure varied over the 1.5-15 torr range. The cylindrical chamber was 8 m long and 0.1 m in diameter. Oscillograms were recorded, to reveal changes in the intensity of visible (400-700 nm), near infrared (800-1200 nm), and far infrared (4000-10,000 nm) radiation. The optical instrumentation included an aperture stop and a field stop, a rotating mirror, and a photodetector. The results indicated, among others, that the strong dependence of the frequency of radiation intensity oscillations in impact-heated Xe plasma on the Mach number of the shock wave and on the initial gas pressure cannot possibly be attributed to plasma flow perturbation by the rough inside surface of the shock tube or to turbulization by contact within the mixing region. The length of the flow region responsible for radiation intensity oscillations was varied over the 1-4 cm range, the entire impact-heated gas lock being 60-80 cm long. It was found to be proportional to the oscillation period and to the

shockwave velocity, inversely proportional to the gas compression. Figures 4; references 11: 7 Russian, 4 Western (1 in Russian translation).

Nonequilibrium Supercooled Beam Plasma

18620157 Moscow FIZIKA PLAZMY in Russian
Vol 14 No 12, Dec 88 pp 73-77

[Article by V. L. Bychkov, A. V. Yeletskiy, V. A. Ushchapovskiy]

[Abstract] This study analyzes a high pressure beam plasma in which the primary volumetric neutralization of charged particles is electron attachment to the molecules. In certain cases the rate constant of this process is characterized by an increasing dependence on electron temperature which causes effective electron cooling. This study establishes the existence conditions for such a plasma state and demonstrates that the parameters of a beam plasma of oxygen and air can be determined with sufficient accuracy by a simple plasmochemical model which includes a limited number of ion-molecular transformations. This model is then used to calculate the parameters of the supercooled beam plasma of oxygen and air. The study also derives balance equations for the charged particles supplemented by a quasineutrality condition of the plasma and an energy balance equation for the electrons accounting for the recombination heating mechanism and the attachment mechanism of electron cooling; these equations are solved numerically for a quasistationary beam plasma of oxygen and air. This study also reports the possible existence of a new and unusual object in low-temperature plasma physics: a nonequilibrium supercooled plasma with an electron temperature below the gas temperature. The possibility is evidently caused by the effective electron cooling mechanism based on the rising temperature dependence of the rate constant of electron attachment to the molecule.

Comments on the Dirichlet Problem for an Ultrahyperbolic Equation and Integral Geometry on a Sphere

18620109a Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian
Vol 43 No 5 (263) Sep-Oct 88 pp 181-182

[Article by V. P. Burskiy]

[Abstract] This note considers the nontriviality of a solution of the homogeneous Dirichlet problem for an ultrahyperbolic equation on a sphere. The study also considers the singularity of the solution of one integral geometry problem. The study presents several theorems and appropriate proofs.

UDC 548.3+537.312.62

Crystal Chemistry and High-Temperature Superconductivity

18620187 Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA. SERIYA 7: GEOLOGIYA I GEOGRAFIYA in Russian No 1 (7), Mar 89 (manuscript received 31 Mar 88) pp 10-17

[Article by V. I. Lebedev]

[Abstract] Following a review of earlier theories of superconductivity developed since its discovery in 1911, the evidence that not metals and intermetallic compounds but dielectric or semiconducting metal oxides become superconducting already at much higher than cryogenic temperatures is analyzed and discussed from the standpoint of crystal chemistry. It is shown that the Goldschmidt-Pauling crystal chemistry does not explain this but the Slater-Lebedev system of atomic and ionic radii involved in the theory of chemical bonds does, while discovery of new and repetitive symmetry of valence electrons explains why by far not all oxides become superconducting. References 20: 15 Russian, 5 Western.

UDC 537.312.62

Possibility of High-Temperature Superconductivity by Interband Electron-Phonon Mechanism

18620166 Tallinn IZVESTIYA AKADEMII NAUK ESTONSKOY SSR: FIZIKA I MATEMATIKA in Russian, Vol 38 No 1, Jan-Mar 89 (manuscript received 9 Nov 87) pp 19-24

[Article by P. Konsin, N. Kristofel, and T. Erd, Institute of Physics, ESSR Academy of Sciences]

[Abstract] On the premise that high-temperature superconductivity of some materials such as $YBa_2Cu_3O_7$ and La_2CuO_4 must be somehow related to certain characteristics of their electron energy spectrum, and considering that an electron-phonon mechanism involving several bands has already been suggested, the concept of an interband electron-phonon mechanism is proposed and developed on a rigorous theoretical basis. Following the Froehlich method, the Hamiltonian is written for electron-phonon interaction of charge carriers on the basis of the effective multiband model but disregarding intraband interaction and also interband interaction which pairs electrons in different bands. The two-band model with positive dispersion is considered, to simplify analysis and necessary interpolations, the Hamiltonian being diagonalized by means of the four-parametric Bogolyubov transformation. With assumptions made in the Bardeen-Cooper-Schrieffer theory, the transform yields a system of two similar equations for the critical superconducting transition temperature. Rough quantitative estimates of that temperature can be made for pure and impure materials on the basis of this mechanism, with the theoretical possibility that superconducting transition at room temperature can be attained. The authors thank V. Khizhnyakov and A. Pishchev for helpful comments. References 34: 7 Russian, 27 Western.

Structure of Superconducting Phases of UBe_{13} and $U_{1-x}Th_xBe_{13}$

18620138e Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 95 No 2, Feb 89 (manuscript received 21 Jul 88) pp 709-722

[Article by I. A. Lukyanchuk and V. P. Mineyev, Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences]

[Abstract] Possible superconducting phase transitions in heavy-fermion compounds $U_{1-x}Th_xBe_{13}$ including UBe_{13} are analyzed in accordance with Landau's theory, for a correlation with the experimentally established constitution diagram, the latter showing one normal-to-superconducting phase transition of the second kind where x is smaller than 0.0175 and two consecutive phase transitions where x is larger than that. Transitions from one superconducting phase to another are considered where both phases originate from the nonmagnetic normal state and where one of them originates from the magnetic normal state. Most likely and consistent with experimental evidence are two schemes: 1) high-temperature transition of the second kind from normal to superconducting phase with O(T)xR symmetry followed by low-temperature transition of the first kind to another superconducting phase with $D_3(C_3)$xR symmetry where x is larger than 0.0175 and only a transition of the second kind from normal to superconducting phase with $D_3(C_3)$xR symmetry where x is smaller than that, 2) high-temperature transition of the second kind from normal to superconducting phase with $O(D_2)$ symmetry followed by low-temperature transition of the first kind to another superconducting phase with $D_3(E)$ symmetry where x is larger than 0.0175 and only a transition of the second kind from normal to superconducting phase with $D_3(E)$ symmetry where x is smaller than that. Figures 6; tables 1; references 33: 12 Russian, 21 Western.

Bound States of Fermions and Superconducting Ground State in 2 + 1 Gauge Theory With Topological Mass Term

18620167b Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 49 No 4, 25 Feb 89 (manuscript received 16 Jan 89) pp 194-197

[Article by Ya. I. Kogan, Institute of Theoretical and Experimental Physics]

[Abstract] The simple 2 + 1 gauge theory with a topological Cherny-Simons mass term for photons and one kind

of fermions, namely electrons, is analyzed on the basis of the corresponding Lagrangian. The topological mass term is found to impart a mass to a photon and an additional transverse structure to the propagator. First is considered interaction of two electrons in the nonrelativistic approximation, describable by the Pauli equation for a particle with reduced mass 1/2m obeying Fermi-Dirac statistics in external electric and magnetic fields. Next is considered multiparticle interaction in a quasi-two-dimensional system with a Fermi energy e_F and a ground state at zero absolute temperature describable by a wave function of the Bardeen-Cooper-Schrieffer kind, for an interpretation of high-temperature superconductivity and possible correlation with models of antiferromagnetic order in CuO ceramics. Figures 1; references 17: 4 Russian, 13 Western (1 in Russian translation).

Atomic Structure in $YBa_2Cu_3O_{7-d}$ Single Crystals With Intermediate-Range Oxygen Content

18620167c Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 49 No 4, 25 Feb 89 (manuscript received 13 Jan 89) pp 222-226

[Article by V. N. Molchanov, L. A. Muradyan, and V. I. Simonov, Institute of Crystallography imeni A. V. Shubnikov, USSR Academy of Sciences]

[Abstract] An experimental study of $YBa_2Cu_3O_{6.24}$, $YBa_2Cu_3O_{6.59}$, $YBa_2Cu_3O_{6.97}$ single crystals was made involving a comprehensive structural examination in an RED-4 X-ray diffractometer with AgK_α-radiation source and graphite monochromator, for refinement of their atomic and twinning structures including rhombic distortion of tetragonal unit cells dependent on the oxygen content. Measurements were made at temperatures through the superconducting transition range, and the critical temperature was found to shift from 50-60 K for $O_{6.24}$-crystals toward 90 K for $O_{6.97}$-crystals. The authors thank A. B. Bykov and O. K. Melnikov for growing the single crystal, S. M. Stishov for preparing them for structural examination, and I. P. Zibrov, S. M. Chigishov, and A. Ya. Shapiro for varying their oxygen content. Figures 2; tables 2; references 8: 2 Russian, 6 Western.

Localization Effects in Atomically Disordered High-Temperature Superconductors

18620138d Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 95 No 2, Feb 89 (manuscript received 18 Jul 88) pp 678-697

[Article by B. A. Aleksashin, V. I. Voronin, S. V. Verkhovskiy, B. N. Goshchitskiy, S. A. Davydov, Yu. I. Zhdanov, A. Ye. Karkin, V. L. Kozhevnikov, A. V. Mirmelshteyn, K. N. Mikhayev, V. V. Serikov, S. M. Cheshnitskiy, Institute of Metal Physics, and M. V. Sadovskiy, Institute of Electrophysics, Ural Department, USSR Academy of Sciences]

[Abstract] An experimental study of $RBa_2Cu_3O_7$ (R-Y,Er,Ho), $La_{1.83}Sr_{0.17}CuO_4$, Bi-Sr-Ca-Cu-O ceramics and $YBa_2Cu_3O_{7-d}$ single crystals was made concerning their structural and superconduction characteristics after bombardment by fast neutrons. Specimens of these materials were produced from CuO, $SrCO_3$, $BaCO_3$, and R_2O_3 (R-Y,La,Er,Ho,Bi) powders, Bi-Sr-Ca-Cu-O with not more than 5 percent excess CuO. They were bombarded with neutrons of at least 1 MeV energy to fluence levels of $2x10^{18}$-$5x10^{19}$ cm^{-2}, at liquid-nitrogen temperature so as to avoid possible "thermochemical" effects occurring at room temperature. Their critical superconducting transition temperature was determined from the temperature dependence of their electrical resistivity and magnetic susceptibility. Also the temperature dependence of the upper critical magnetic field was measured, the main purpose being to determine the first derivative of this critical field with respect to temperature at the critical temperature. Measurements were made over the 300-4.2 K temperature range, with a Pt resistance thermometer down to 20 K and with a Ge resistance thermometer below 20 K. Electrical resistivity was measured by the current-voltage method with direct current. Magnetic susceptibility was measured by the Faraday method in a magnetic field 0.6 T strong. This measurement was supplemented with nuclear-quadrupole-resonance spectroscopy of ^{63}Cu in Cu(1) and Cu(2) positions, at 78 K temperature, for a determination of the spin-lattice relaxation time. Examination of the disordered structure was done by the neutron diffraction method and nuclear-magnetic-resonance spectroscopy, with phase analysis by the X-ray diffraction method. On the basis of all these data and by extension of known theories applicable to ordered superconductors are evaluated the effects of localization by neutron bombardment on the characteristics of quasi-two-dimensional superconductors, of special concern being degradation of the critical superconducting transition temperature. That temperature is evidently descending fast as the degree of disorder reaches levels corresponding to an exponential temperature dependence of electrical resistivity, till no superconducting transition occurs when the energetic split between localized states becomes comparable with the superconductor energy gap. Figures 9; references 33: 15 Russian, 18 Western (2 in Russian translation).

Superconductivity in Tl-Ca-Ba-Cu-O System

18620151e Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 15 No 2, 26 Jan 89 (manuscript received 5 Sep 88, in final version 8 Dec 88) pp 86-89

[Article by I. V. Vodolazskaya, V. I. Voronkova, and V. K. Yanovskiy, Moscow State University imeni M. V. Lomonosov]

[Abstract] An experimental study of Tl-Ca-Ba-Cu-O superconductor ceramics was made, for the purpose of determining the dependence of their superconductivity on the phase composition and on the treatment after synthesis. Specimens of three compositions (1:1:1:2, 2:2:1:3, 2:2:2:3) compacted into 1.5-2 mm thick disks

10-20 mm in diameter were hat treated at 910-930 ° C for 5 min in an oxygen stream and quenched. Some of them were then used directly for phase analysis by the x-ray diffraction method and electrical resistance measurements over the 300-80 K temperature range. Others were prior to that crushed and again compacted, then similarly heat treated for 5 min: 1 1 1 2 and 2 2 2 3 specimens twice at 930 ° C successively. Reaction occurring during the first high-temperature heat treatment already was found to have converted all specimens into mixtures of 2-1-2-2 and 2-2-2-3 phases, the tetragonal dominant 2-1-2-2 phase appearing in three different modifications and the volume fraction of the 2-2-2-3 phase increasing from a small 5-15 percent after the first heat treatment to up to 40 percent after subsequent ones. The temperature dependence of their electrical resistivity reveals a superconducting transition already after the first heat treatment, the range of this transition becoming narrower and shifting toward higher temperature after each successive heat treatment and thus evidently owing to a larger volume fraction of the 2-2-2-3 phase. For the best specimens the critical temperature was 108 K within a 10 K wide range. Figures 1; references 5: Western.

Cathodoluminescence of Y-Ba-Cu-O High-Temperature Superconductors

18620148e Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 48 No 11, 10 Dec 88 (manuscript received 25 Oct 88) pp 616-618

[Article by M. N. Popova, Institute of Spectroscopy, and Ye. P. Khlybov, Institute of High-Pressure Physics, USSR Academy of Sciences, A. V. Puyats and M. Ye. Springis, Scientific Research Institute of Solid-State Physics, Latvian State University]

[Abstract] An experimental study of ceramic YBa2Cu307-d superconductors was made concerning their cathodoluminescence, Gd having been introduced to serve as light probe. Compacts of these ceramics were bombarded, under a vacuum of 3.10-6-2.10-7 mm Hg, with 2-8 keV electron beams producing current densities of 0.020-0.050 mA/cm2. Luminescence covering the 220-550 nm region of the spectrum was recorded with an FEU-106 photomultiplier after passage through an MDR-2 monochromator with a 0.6 nm wide spectral window, at temperatures covering the 300-85 K range and over a time period from freshly cut ceramic plates to half a year later. The experiment included also removal of a ceramic plate from the cryostat and replacing it with a freshly cut plate of metallic In, then soldering the In plate to the specimen holder with ZnCl2 flux. The initially weak glow with narrow 3.31 eV and 3.36 eV lines becoming more intense in time indicates that cathodoluminescence of YBa2Cu307-d ceramic is caused by absorbed impurities. Cathodoluminescence of fresh specimens was evidently caused by inclusions comprising extraneous phases, the doublet of intense 314 nm and 316 nm lines being attributable to Gd3plus-ions acting as very sensitive detectors of the green phase. The authors thank Ya.A. Valbis for helpful discussion, G.N. Zhizhin and V.V. Yevdokimov for interest. Figures 1; references 8: 6 Russian, 2 Western.

Characteristic Loss Spectroscopy of YBa2Cu307-d Superconductor Ceramic

18620148f Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 48 No 11, 10 Dec 88 (manuscript received15 Nov 88)pp 633-634

[Article by I. V. Kireyev, M. N. Mikheyeva, V. G. Nzin, and A. V. Svishchev, Institute of Atomic Energy imeni I.V. Kurchatov]

[Abstract] An experimental study of YBa2Cu307-d superconductor ceramic was made concerning the dynamics of changes in its surface properties and involving characteristic loss spectroscopy based on inelastic scattering of electrons, the form of the spectrum being determined by the inverse function of dielectric permitivity as well as by interband transitions of electrons from occupied to vacant states and by plasma oscillations. The spectrum should contain peaks at 7.5 eV and 9.5 eV according to the theoretically calculated density of states or at 9.3 eV and 11.5 eV according to the density of states determined experimentally by photoelectron spectroscopy and back-photoemission radiography. Measurements made under a high vacuum of 3.10-10 torr over a period of 800 s after mechanical surface treatment with a scraper revealed, however, changes within both 3-13 eV and 20-27 eV ranges occurring most drastically during the first 180 s. Admission of oxygen resulted in intensification of the peaks at 12.5 eV and 22.5 eV. The peak at 25.5 eV is attributable to volume plasma oscillations in fresh ceramic. Evidently photoelectron spectroscopy and back-photoemission radiography should be performed at least 10 min after surface treatment of specimens. Figures 1; references 5: 1 Russian, 4 Western.

Raman Scattering of Light in Tunneling-Transparent Superlattices

18620146d Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 94 No 12, Dec 88 (manuscript received 16 Apr 88) pp 251-256

[Article by A. O. Govorov and A. V. Chaplik, Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] Raman scattering of light in multilayer superlattices is analyzed, including the effect of electron tunneling between layers of subnanometer thickness attainable by methods of modern technology. First is considered off-resonance scattering, the frequencies of both incident and scattered waves being far below resonances with miniband- to-miniband transitions within

one band, in which case calculations in the effective-Hamiltonian approximation indicate that the nonshielded part of the scattering cross-section can predominate even at a quite low probability of tunneling. Next is considered resonance scattering, the frequency of the incident wave approaching the width of the forbidden band. In this case that approximation ceases to be valid and calculations based on explicit relations taking into account finite transparence barriers yield a nonshielded scattering component associated with tunneling and two competing mechanisms of nonshielded scattering unrelated to tunneling. The authors thank I. P. Ipatova and A. Maslov for discussion and helpful comments. References 13: 2 Russian, 11 Western (1 in Russian translation).

Critical State of and Hystersis Losses in Metal-Oxide Superconductors

18620149b Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 22, 26 Nov 88 (manuscript received 26 Jul 88) pp 2094-2097

[Article by Yu. F. Revenko, A. I. Dyachenko, O. V. Grigut, and V. M. Svistunov]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-d}$ superconductor ceramic was made in which its magnetic susceptibility and critical current density were measured over the 95-85 K temperature range. Specimens of this ceramic, 5 mm long and 1.5 x 2 mm^2 in cross-section, were produced by solid-phase synthesis of oxides forming a material with a critical superconducting temperature of 93 K within a 2-3 K wide range based on electrical resistance measurements. The magnetic susceptibility was resolved into its in-phase and dissipative quadrature components, each being measured separately at a frequency of 2 kHz by the synchronous detection method with the external magnetic field shielded down to 10^{-6} T level and the quadrature component measured during reheating in an alternating magnetic field of 10^{-5} T. The results indicate that during cooling the in-phase component of magnetic susceptibility decreases steeply to zero and the critical current density increases increasingly faster, while during reheating the quadrature component of magnetic susceptibility increases increasingly faster to a maximum at a temperature slightly below T_{c0} and then decreases steeply to zero at T_c. This behavior of the quadrature component is attributed to hysteresis losses during magnetization reversal in a granular cluster in an alternating magnetic field, additional losses associated with quasiparticles of the normal phase occurring in the vicinity of T_{c0}. The hypothesis is supported by field calculations for a plane-parallel plate of ceramic as weak-link Josephson medium. These calculations yield the ratio of mean critical to pinning current density and the ratio of quadrature to maximum quadrature magnetic susceptibility in terms of their dependence on the hysteresis loss. Figures 2; references 6: 3 Russian, 3 Western (1 in Russian translation).

Structural and Physical Characteristics of Bi-Sr-Ca-Cu-O Superconductor Crystals

18620149c Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 22, 26 Nov 88 (manuscript received 18 Jul 88) pp 2097-2101

[Article by M. P. Petrov, A. I. Grachev, A. V. Kartenko, V. A. Pimenov, V. V. Poborchiy, V. V. Potapov, S. S. Ruvimov and S. I. Shagin]

[Abstract] An experimental study of Bi-Sr-Ca-Cu-O crystals was made concerning their structural and physical characteristics. Specimens of these crystals were produced from Bi_2O_3, $SrCO_3$, $CaCO_3$, CuO in a 2:2:1:2 ratio by spontaneous crystallization from the melt during slow cooling, synthesis in a platinum crucible in air occurring at a temperature within the 1000-1200° C range and cooling to 800° C occurring not faster than 5°/h. The glassy product contained black crystallites of the 10 mm^3 size fraction and 0.010 mm thick crystalline wafers with a surface area not larger than 1 mm^2. Structural examination and phase analysis by the x-ray diffraction method revealed a predominance of two phases: $Bi_2Sr_{2.2}Ca_{0.7}Cu_2O_{\ x}$ and $Bi_2Sr_{1.25}Ca_{0.25}CuO_y$. Physical characteristics and superconducting transition were determined from the temperature dependence of electrical resistance and magnetic susceptibility, the electrical resistance of polycrystalline conglomerates being measured by the voltage-current method with direct current and the magnetic susceptibility of individual crystallites being measured by the differential method with alternating current at a frequency of 2 kHz. The critical superconducting transition temperature for not additionally annealed specimens was found to spread widely over the 84-79 K range according to electrical measurements, the transition beginning at 84 K and at a somewhat higher temperature after annealing in an oxygen atmosphere according to magnetic measurement. The critical temperature for some specimens produced with the ingredients in a different ratio was found to be 115 K according to electrical measurements. Optical measurements under a polarizing reflection microscope revealed twins with (100) or (110) twinning planes and an anisotropy of optical properties in the a-b plane. The authors thank S. G. Konnikov and V. V. Tretyakov for performing the microanalysis of crystallites with a probe. Figures 3; references 7: 1 Russian, 6 Western.

New Method of Producing Photosensitive Schottky Barriers With Schistose InSe and GaSe Semiconductors

18620149d Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 22, 26 Nov 88 (manuscript received 20 Jun 88) pp 2104-2107

[Article by M. V. Tovarnitskiy, V. K. Lukyanyuk, Z. D. Kovalyuk, V. I. Vitkovskaya, and S. Ya Golub]

[Abstract] A new method of producing photosensitive Schottky barriers with InSe and GaSe semiconductors is proposed, large schistose single crystals of these materials

being grown by the Bridgman method so that slicing along cleavage planes yields wafers of required thickness with a mirror surface without further treatment. Such wafers are annealed in a Zn-vapor atmosphere at 400° C for several hours, which results in formation of a ZnSe layer with an f.c.c. crystal lattice on their surface: a polycrystalline one on InSe and a single crystal on GaSe. This was established on the basis of phase analysis by the x-ray diffraction method in an IRIS-O Debye rotation chamber with FeK_{alpha}-radiation and Fe_{β}-radiation sources. The capacitance-voltage characteristic of an InSe-ZnSe heterojunction at 295 K temperature was measured over the -1.8-(0.6) V range at frequencies from 10 to 20 kHz. The frequency characteristic of the cutoff voltage measured at the same temperature yielded a barrier height of 0.86 V. The spectral characteristic of the relative quantum efficiency of InSe-ZnSe and GaSe-ZnSe heterojunctions at 295 K and 120 K temperatures were measured over the 1.2-3.2 eV range. Figures 2; references 6: 3 Russian, 3 Western.

UDC 537.312.62

Pressure Dependence of Fluctuation Effects in Cermet Superconductors

18620147d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 30 No 11, Nov 88 (manuscript received 26 Apr 88, in final version 13 Jun 88) pp 3498-3501

[Article by V. M. Svistunov, V. Yu. Tarenkov, A. I. Dyachenko, O. V. Grigut, O., I. Chernyak, and A. V. Vasilenko, Donetsk Institute of Engineering Physics, UkSSR Academy of Sciences, Donetsk]

[Abstract] An experimental study of $YBa_2Cu_3O_{7-d}$ ceramic has revealed an appreciable narrowing of the temperature range of superconducting transition under increasing hydrostatic pressure up to almost 1.0 GPa, evidently owing to shrinkage of the temperature range of order-parameter phase fluctuations. In departure from the standard technology, therefore, compact specimens of pure 1-2-3 phase were produced from powder under a pressure of almost 3.0 GPa and annealed at a temperature of 1200 K in air. Electrical measurements and temperature readings have yielded a transition from 50 percent to 1.0 percent of normal resistance with a temperature range which narrows down with increasing pressure, the derivative of the logarithmic decrement of the temperature range with respect to pressure being equal to 0.6/GPa. This trend, indicating an abatement of fluctuation effects under high pressure, is most plausibly explained by treating this cermet as a weak-link Josephson medium consisting of superconducting granules and normal interlayers. Figures 2; references 8: 4 Russian, 4 Western (1 in Russian translation).

Frequency Mixing in Josephson Junction Made of $YBa_2Cu_3O_x$ Ceramic

18620144b Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 21, 12 Nov 88 (manuscript received 12 May 88) pp 1949-1952

[Article by A. V. Drobinin and V. S. Lutovinov, Moscow Institute of Radio Engineering, Electronics, and Automation]

[Abstract] An experimental study of frequency mixing in Josephson junctions made of $YBa_2Cu_3O_x$ ceramic was made, mixing with the frequency of an external oscillator rather than with the frequency of the junction as internal oscillator being considered. A junction specimen in the form of a 10 mm long bar 1 x 3 mm^2 in cross-section was filed down to neck 0.1 mm^2 in cross-section and a reinforcing substrate of nonsuperconducting ceramic with approximately the same coefficient of thermal expansion was bonded to that neck with an adhesive for protection against rupture during cooling. Three electromagnetic waves were mixed, two with slightly different frequencies about 7 GHz and one with a frequency of 21 GHz. Signals at combination frequencies including harmonics within the 1-100 MHz range were recorded with a spectrum analyzer. The differential impedance of the junction in a 7 GHz microwave field and in a 21 GHz microwave field as well as, for comparison, without a microwave field was measured with the d.c. bias voltage across the junction varied from -0.3 V through 0 to 0.3 V. The results indicate that a strong microwave field tends to synchronize the links between individual granules in the ceramic structure, just as in a superconducting compacted Nb-powder structure. Figures 2; references 3: 1 Russian, 2 Western.

Effect of Constant Magnetic Field on High-Frequency Surface Resistance of $YBa_2Cu_3O_{7-d}$ Ceramic

18620144c Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 14 No 21, 12 Nov 88 (manuscript received 1 Jul 88) pp 2001-2004

[Article by O. G. Vendik, M. M. Gaydukov, I. E. Graboy, A. Karpyuk, A. R. Kaul, L. Kovalevich, A. B. Kozyrev, and S. G. Kolesov, Leningrad Institute of Electrical Engineering imeni V. I. Ulyanov (Lenin)]

[Abstract] In an experimental study of $YBa_2Cu_3O_{7-d}$ bulk ceramic with an electrical resistivity of 0.1

mohm.cm the surface resistance was measured at two frequencies, 37 MHz and 60 GHz, during cooling from 300 K to 4.2 K in a constant external magnetic field. The surface resistance at 4.2 K was also measured at both frequencies, for a determination of its dependence on the density of magnetic flux trapped in the ceramic. The surface resistance at 4.2 K was then measured at 37 MHz only with an alternating magnetic field superposed on the constant one, for a determination of its dependence on the amplitude of that high-frequency alternating magnetic field at various densities of trapped magnetic flux. Specimens of this ceramic had been produced by coprecipitation of nitrates from the mixture of their solutions. Their critical superconducting transition temperature was approximately 94 K within an approximately 1.5 K wide range and their volume resistance was approximately 60 pct lower at 100 K than at 300 K. The surface resistance was measured by the Q-factor method on high-frequency and microwave resonators made of this ceramic. The results agree closely with theoretical estimates based on the model of Josephson inductances in parallel with normal resistances as an equivalent circuit of intergranular Josephson junctions, according to which an increase of shielding with an increase in the density of trapped magnetic flux results in higher losses in the normal zones. Figures 2; references 5: 3 Russian, 2 Western.

Determination of the Depth of Penetration of a Magnetic Field Into a $YBa_2Cu_3O_7$ Superconducting Thin Single Crystal Film by Polarized Neutron Reflection

18620165d Moscow PISMA V ZHURNAL EKSPERIMENTALNOY FIZIKI in Russian Vol 49 No 5, 10 Mar 88 pp 277-280

[Article by S. V. Gaponov, Ye. B. Dokukin, D. A. Korneev, Ye. B. Klyuyenkov, V. Lebner, V. V. Pasyuk, A. V. Petrenko, Kh. Rzhany, L. P. Chernenko]

[Abstract] This study reports results from initial measurements of the depth of penetration of a magnetic field into a thin-film $YBa_2Cu_3O_7$ single crystal specimen by specular reflection of polarized thermal neutrons on the IBR-2 pulse reactor at the Joint Institute for Nuclear Research. In these analyses the depth of penetration of the magnetic field is measured along a specified crystallographic directions, in this case along the c crystallographic axis. The specimen was a film with T_c = 92 K obtained by laser deposition of a $SrTaO_3$ single crystal onto a polished (1,0,0) surface. The specimen area was 6 by 8 mm^2. The depth of penetration measurements were carried out for two field values: 200 Oe, and 500 Oe. The derived experimental data were compared to model calculations for a field intensity of 500 Oe. A final depth of penetration of 970 plus or minus 600/250 angstroms was obtained for these specimens at T = 5.2 K.

END OF
FICHE
DATE FILMED
2 OCT 1989